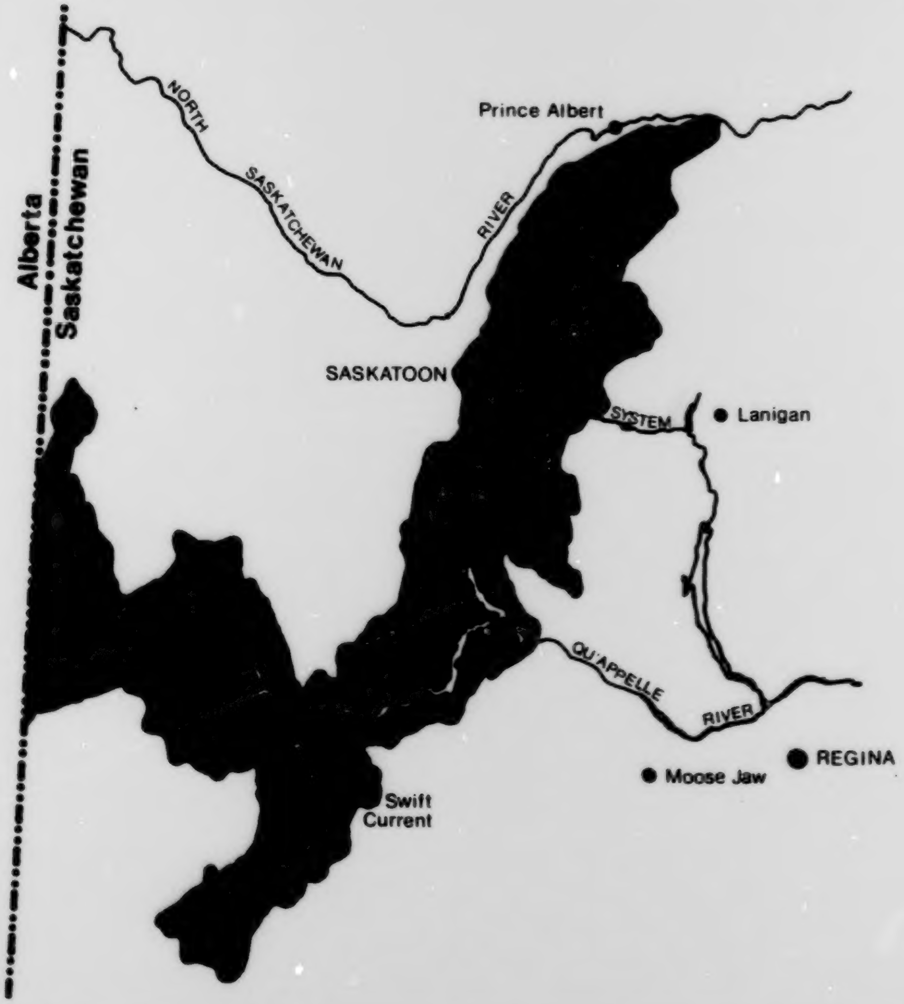
# SOUTH SASKATCHEWAN RIVER BASIN STUDY

# FISHERY SURVEY OF THE SOUTH SASKATCHEWAN RIVER AND ITS TRIBUTARIES IN SASKATCHEWAN



SASKATCHEWAN WATER CORPORATION

Environment Canada Environnement Canada

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# FISHERY SURVEY OF THE
# SOUTH SASKATCHEWAN RIVER AND ITS
# TRIBUTARIES IN SASKATCHEWAN

# EXECUTIVE SUMMARY

A study of fish and invertebrate fauna of the South Saskatchewan River and its tributaries (Swift Current Creek and the Saskatoon Southeast Water Supply) was commissioned by the Water Quality Committee of the Canada - Saskatchewan South Saskatchewan River Study. The study, undertaken by the Fisheries Branch, Saskatchewan Parks, Recreation and Culture, in the summer of 1988, documents the diversity and relative abundance of fish and invertebrates at 5 sites in the South Saskatchewan River in Saskatchewan, 2 reservoirs in the Swift Current Creek drainage and 5 reservoirs in the Saskatoon Southeast Water Supply.

The diversity and abundance of invertebrate fauna is related to the type and stability of sediments. Sandy substrates produce the smallest quantity and diversity of invertebrate biomass. Organic ooze is the most productive. Changes in the use of the river or reservoir systems which affect the quantity and type of substrate will affect the invertebrate fauna which in turn provide food for a variety of fish species.

Twenty-seven species of fish were collected by gillnetting or seining in the South Saskatchewan River and adjoining systems. Highest yields of fish were obtained from the reservoirs of the Saskatoon Southeast Water Supply System. The greatest diversity of species was caught downstream of the Gardiner Dam. This included species typical of lakes (lake whitefish and ciscoes) and introduced species (rainbow trout and brook trout) in a unique habitat created by the cold clean water discharged from Lake Diefenbaker.

# FISHERY SURVEY OF THE SOUTH SASKATCHEWAN RIVER AND ITS TRIBUTARIES IN SASKATCHEWAN

PRESENTED TO
THE WATER QUALITY COMMITTEE
SOUTH SASKATCHEWAN RIVER BASIN STUDY
SASKATOON, SASKATCHEWAN

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FISHERIES TECHNICAL REPORT 88-6
NOVEMBER, 1988

SASKATCHEWAN FISHERIES LABORATORY
SASKATCHEWAN PARKS, RECREATION AND CULTURE
15 INNOVATION BOULEVARD
SASKATOON, SASKATCHEWAN
S7K 2H6

Distribution of fish in the River is related to River use. The least suitable habitat for fish is the stretch of river upstream of Saskatoon to Lake Diefenbaker. The modified habitat downstream of Saskatoon provides vegetation and organic substrate more suitable for pike, walleye and several species of suckers. The conditions upstream of Lake Diefenbaker are most typical of river conditions prior to 1960 where goldeye, sauger, walleye and sturgeon predominate.

A reduction in goldeye and sturgeon and an increase in walleye downstream of Lake Diefenbaker appears to be linked to flow modifications and physical barriers which affect migration and river spawning of goldeye and sturgeon. Walleye populations in the river may be replenished by strong reproducing stocks in Lake Diefenbaker.

Sport fish populations in the reservoirs of the Saskatoon Southeast Water Supply are being maintained through a stocking program of Saskatchewan Parks, Recreation and Culture. Suckers, whitefish and forage fish species have been introduced from Lake Diefenbaker via the water supply canal system.

An analysis of samples of fish tissues shows a continued presence of higher than normal levels of mercury downstream of Saskatoon. The levels are generally within the range appropriate for limited consumption. Significant levels of zinc are also reported. Mercury levels in fish caught in the reservoirs of Swift Current Creek and the Saskatoon Southeast Water Supply are generally less than 0.5 $mg.kg^{-1}$, the level considered safe for normal use.

Spring runoff conditions and river flows were too low to adequately assess the significance of tributary streams for spawning.

The study recommends an indepth examination of the utilization of the fishery resource in the South Saskatchewan River, and a more detailed study of the sturgeon populations. Any modifications of river use patterns should consider implications to spawning success and habitat alteration of common species of economic significance including walleye, northern pike, goldeye, lake whitefish and sturgeon. Monitoring of mercury levels in fish of the South Saskatchewan River basin should be continued, especially downstream from Saskatoon.

# ACKNOWLEDGEMENTS

The South Saskatchewan River Basin Study and Saskatchewan Department of Parks, Recreation and Culture, Fisheries Branch provided funds for the project. The assistance of G. Sedgewick, D. Gullickson, C. Russell, and S. Johnson in the collection of field data was greatly appreciated, as was the co-operation of Resource Officers at Maple Creek, Danielson Park, Saskatoon, and Prince Albert. Analysis of invertebrate and seine hauls, and drafting for the report was done by G. Sedgewick and J. Matthews. We thank B. Musker for ageing fish collected and C. Schurr for her patience in typing the manuscript.

In addition, we would like to extend thanks to all those who offered assistance and guidance throughout the course of the study, particularly W. Liaw and J. Merkowsky.

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# 1. INTRODUCTION

The South Saskatchewan River flows from the confluence of the Bow and Oldman rivers eastward across the Alberta Plateau and Saskatchewan Plains until it joins the North Saskatchewan River east of Prince Albert. The river has been used for transportation since the 1870s (Beak Assoc. 1987) and today is used as a domestic, industrial, agricultural and hydroelectric water source (Kulshreshtha *et al.* 1987).

The most comprehensive survey of the South Saskatchewan River, conducted by Reed (1962) in 1957-58 is now outdated by the construction of Gardiner Dam and resultant flow modification. The lack of current information available on the existing fishery resource in the river prevents a valid assessment of the impact of human activity on this resource. Consequently, a survey was conducted in 1988 by the Fisheries Research Laboratory in Saskatoon in co-operation with the South Saskatchewan River Basin Study to examine the fishery resource in the South Saskatchewan River.

# 2. STUDY AREA

## 2.1 DRAINAGE BASIN

The South Saskatchewan River is formed by the confluence of the Bow and Oldman rivers and is fed by the Red Deer River which flows into it near the Alberta-Saskatchewan border. All three of these rivers drain the eastern slopes of the Rocky Mountains, but only the Bow and Red Deer rivers are fed by glacial melt waters (Ashmore 1986). From the confluence of the Bow and Oldman rivers, the South Saskatchewan River flows approximately 1 000 km to its confluence with the North

Saskatchewan River. As it crosses the Alberta Plateau, gravel and boulder are the primary substrate constituents, but upon reaching the Saskatchewan Plains, mud and sand abruptly begin to dominate (Ashmore 1986). Within Saskatchewan, the South Saskatchewan River is characterized by continuously shifting sandbars.

Approximately 700 km of the South Saskatchewan River lie within Saskatchewan, draining an estimated 49 000 km$^2$ (Kulshreshtha *et al.* 1987). The surface of the drainage basin is the result of deglaciation and varies in composition and depth (Reed 1962). The major components are highly fertile brown and black prairie soils with a 2 500 km$^2$ block of infertile sandhills located west of Swift Current (Kulshreshtha *et al.* 1987). Much of the natural vegetation, described in depth in Richards and Fung (1969), has been replaced by agriculture since the advent of European settlers (Ashmore 1986).

In addition to the Red Deer River, Swift Current Creek is a major tributary of the South Saskatchewan River. It rises on the northeast slopes of the Cypress Hills and empties into Lake Diefenbaker, having only a nominal effect on the flow of the main stream (Kulshreshtha *et al.* 1987). The local drainage system of Beaver Creek flows into the river approximately 10 km above the city of Saskatoon.

## 2.2 CLIMATE

Kulshreshtha *et al.* (1987) classified the climate of the South Saskatchewan River basin as 'cold continental.' Within one year, air temperatures can change as much as 80°C with a range of 40°C to -40°C. A minimum mean temperature of -20°C, is the norm, however, and usually occurs in January while a maximum mean temperature of 22.5°C is usually reached in July (Ashmore 1986).

The basin can also be described as semi-arid as the mean annual precipitation of 300 mm in the south and 400 mm in the north is exceeded by potential evaporation (Kulshreshtha *et al.* 1987).

## 2.3 HYDROLOGY

In the years preceding 1964, the flow regime of the South Saskatchewan River was characterized by two peaks of high water annually, with flow ratios as high as 100:1 (Reed 1962). The first peak occurred in April resulting from run-off of snow melt from the prairies. The second generally occurred in June or July with the arrival of meltwater from the mountainous headwater regions.

Since the completion of Gardiner Dam in 1967, the flow below the dam has become relatively even throughout the year. The mean annual peak flow for 1968-1985 was approximately 60% less than that recorded for 1946-63 and the total annual flow was reduced by approximately 30% (Yuzyk 1987). Observations made on both regulated and non-regulated streams for the period 1963-1983, showed that mean annual discharge closely followed a pattern of variation in mean annual precipitation (Ashmore 1986), indicating that natural hydrological conditions are a major influence on long-term trends in flow. Therefore, some of the reduction in flow reported by Yuzyk (1987) for the South Saskatchewan River is probably due to the drying trend which started in the 1970s and has continued into the 1980s.

## 2.4 WATER USES

The South Saskatchewan River is the only dependable, high quality water source in southern Saskatchewan (Engel 1987). Major centres which utilize water from the river basin for domestic and industrial purposes, hydroelectric power generation, irrigation, transportation, and recreation include Saskatoon, Regina, Swift Current, and Moose Jaw.

Kulshreshtha *et al.* (1987) and Engel (1987) looked at water consumption in the southern half of the province. They reported the following:

1. Forty percent of the province's population receive its domestic water from the mainstem of the river, from diversions (i.e. Saskatoon Southeast Water Supply), or from subsurface basin water.
2. Seven out of 10 of the province's potash mines use water from the South Saskatchewan River basin for processing.
3. Thirty thousand hectares of land are irrigated by water from the basin.

Coteau Creek power generating station at Gardiner Dam and the Queen Elizabeth II substation south of Saskatoon are the only two power generating stations that use water directly from the South Saskatchewan River (Beak Assoc. 1987).

The South Saskatchewan River has been used for transportation since the 1870s and today, 9 ferries still operate on the river (Beak Assoc. 1987). These include Estuary, Lemsford, and Lancer ferries above Lake Diefenbaker; Riverhurst Ferry on Lake Diefenbaker, and Clarkboro, Hague, St. Laurent, Fenton, and Weldon ferries between Saskatoon and the confluence with the North Saskatchewan River.

Nine regional parks, 4 provincial parks, 4 cottage developments, 1 recreation site, and 3 institutional camps are located on or near the South Saskatchewan River where people depend upon the river for the enjoyment of numerous recreational activities. These activities are outlined in depth in Beak Associates (1987) and include swimming, boating, waterskiing, kayaking, fishing, hunting, ice fishing, sailing, snow mobiling, as well as bird watching and nature photography.

## 3. METHODS AND MATERIALS

Five sites were sampled on the South Saskatchewan River between the Alberta-Saskatchewan border and the confluence with the North Saskatchewan River at the Forks (Fig. 1). These sites are as follows:

1. Estuary Ferry -109°50' 50°57' - upstream of Lake Diefenbaker near the Alberta border.
2. Gardiner Dam -106°52' 51°17' - within 1 - 2 km downstream of the turbine outflow.
3. Yorath Island - 106°45' 52°05' - upstream of Saskatoon and downstream of Beaver Creek.
4. Clarkboro Ferry - 106°27' 52°19' - downstream of Saskatoon.
5. Fenton Ferry - 105°35' 53°02' - upstream of the Forks, south of Prince Albert.

Specific sampling locations were selected within approximately 1 km of River reach but may have varied between sampling periods depending on factors such as water depth, velocity and substrate.

The sites were chosen as being representative of a variety of fish habitats created by natural flows and stream modifications. They were also chosen for ease of access and because they had been sampled during 1957 and 1958 (with the exception of the Gardiner Dam site) in a study conducted by E.B. Reed (1962). Each site was sampled 4 times throughout May-August, 1988, at approximately 3 week intervals. (See Appendix 1 for sampling dates) Flow conditions and water levels were provided for each site during the sampling (Appendix 1) by Beak Associates Consulting Ltd.

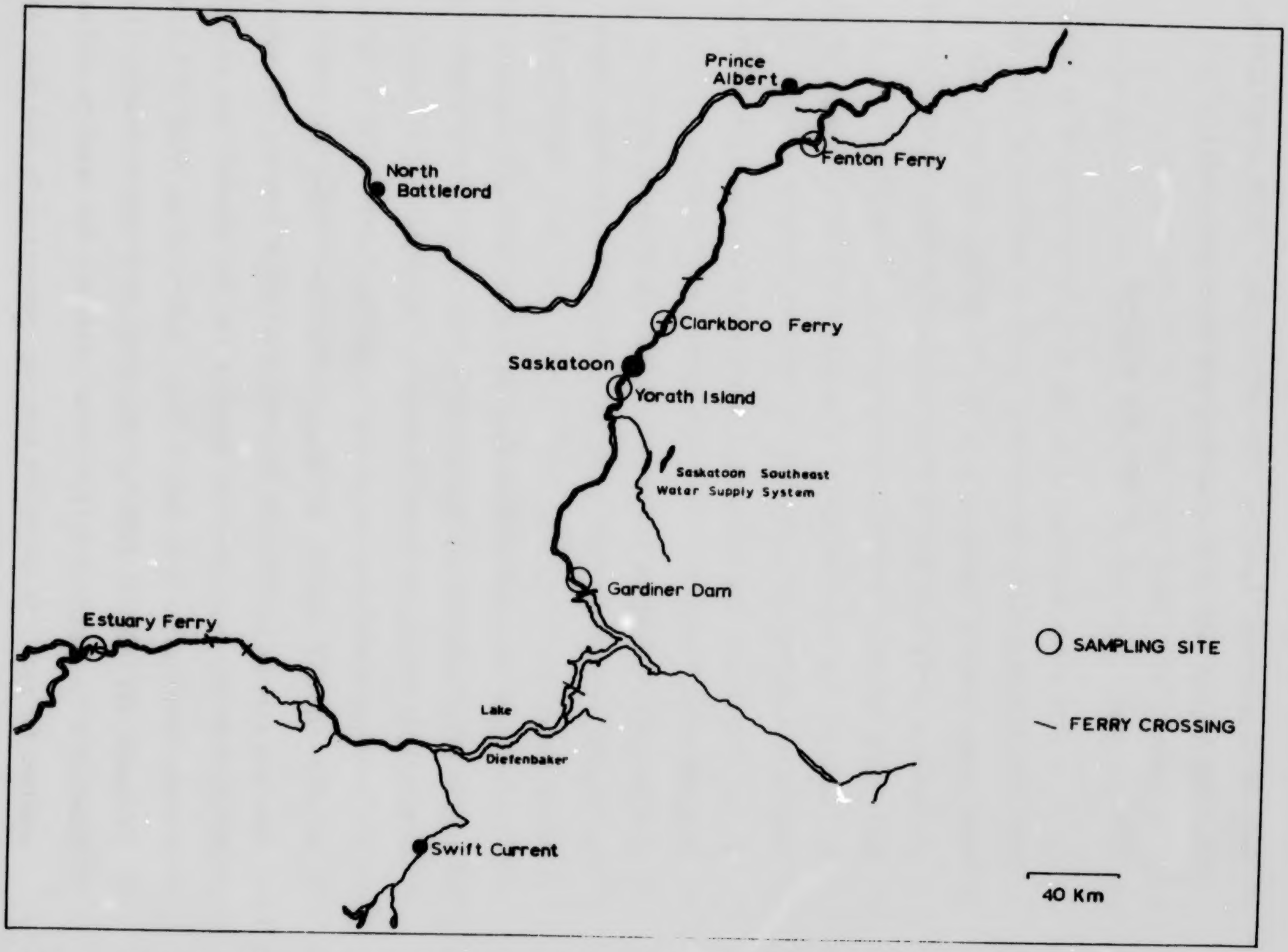


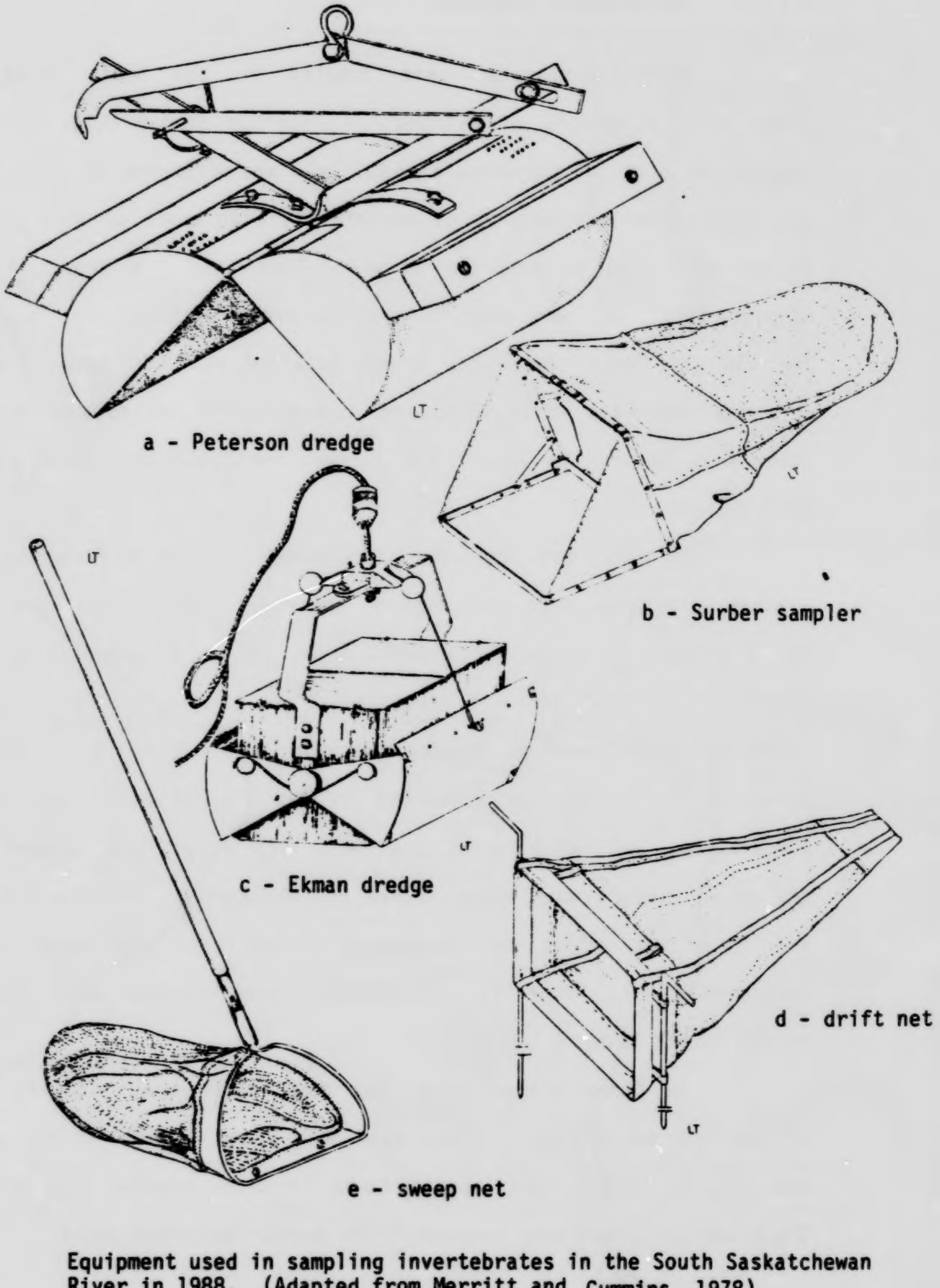
Fig. 1. Schematic diagram of location of sample sites on the South Saskatchewan River.

## 3.1 INVERTEBRATE SAMPLING

Macroinvertebrates were sampled in the South Saskatchewan River using a variety of methods. A Petersen dredge (Fig. 2a), which samples an area of approximately 220 $cm^2$, was attached to long handles and used to collect samples of benthic fauna in areas of soft sediment. It was effective in sampling in water less than 1 m deep. A Surber sampler (Fig. 2b) was used in shallow areas with a rocky substrate. The 930 $cm^2$ brass frame with a net attached at right angles, was set over the substrate while rocks and stones within the boundaries of the frame were scoured by hand. The current swept any dislodged organisms into the net.

On each sampling date, a minimum of 3 Surber samples and 3 dredges were taken near each bank of the river. Both sides were sampled in an attempt to account for differences in faunal composition due to tributary inflow, effluent discharge, or other factors. Organisms collected were washed through screens with 5.5, 8.7, and 11.0 $meshes \cdot cm^{-1}$, picked and preserved in 70% alcohol for identification, enumeration, and weighing in the lab. Dry weight was assumed to be 12% of wet weight when midge larvae (chironomidae) dominated the sample and 15% of wet weight when freshwater shrimp (amphipods) were the major component (Sask. Fisheries Lab. 1964). Invertebrates were identified to the family level.

An Ekman dredge (Fig. 2c) samples an area similar to that of the Petersen dredge. It was used July 5 and July 27 at the Gardiner Dam site to sample invertebrate fauna in water greater than 2 m deep. Organisms collected were treated in the manner described above.



a - Peterson dredge

b - Surber sampler

c - Ekman dredge

d - drift net

e - sweep net

Fig. 2. Equipment used in sampling invertebrates in the South Saskatchewan River in 1988. (Adapted from Merritt and Cummins, 1978).

Drift nets (Fig. 2d) were used during daylight hours to collect drift fauna. The nets were anchored in the river using 2 poles and left for a minimum of 1 hour during which time, organisms carried by the current collected in the net. These organisms were preserved in 70% alcohol for later analysis. Similar to the benthic sampling, drift netting was carried out on both sides of the river. Sample drift density was calculated by the equation given by Allan and Russek (1985):

$$\text{sample drift density} = \frac{\text{numbers per net-hour}}{\text{m}^3 \text{ filtered per net-hour}} \times 100$$

In this equation, m$^3$ filtered per net-hour is estimated from the area of net mouth and the current at the net mouth. It provides a single estimate of numbers drifting per 100 m$^3$ of water filtered for an individual hourly sample. Stream flow was determined using a Teledyne Gurley current meter, Model 625.

Sweep nets (Fig. 2e) were used to collect invertebrates in areas of shallow water with a thick growth of vegetation. The net was held with the mouth facing upstream and dragged through the vegetation as the collector walked backward. Organisms dislodged in this manner were swept into the net from where they were picked and preserved in 70% alcohol for future analysis. Sweep nets were used periodically in areas of suitable substrate.

## 3.2 FISH SAMPLING

Large fish species were sampled using gillnets. The standard gang of gillnet, comprised of 6 different mesh sizes, has long been used as a standardized measure of fish populations in Saskatchewan lakes. Since a standard gang (274 m in length) would be difficult to manage in a fluvial environment, a smaller quarter standard gang of gillnet was used (11.5 m each of 3.8, 5.1, 7.6, 10.2, 12.7, and 14.0 cm mesh size). Two quarter gangs were set and left overnight, then lifted or reset.

Each fish caught in the gillnets was identified to species and measurements of fork length and weight were recorded. The sex was determined and state of maturity was classified as immature, mature, or spent (post spawning). As the field season progressed, it became difficult to distinguish between those individuals that had spawned in the spring and those mature individuals that had not. At this point fish were classified as either mature or immature.

Ageing media were taken from all fish for laboratory analysis. The body structure taken varied according to the species. Scales were taken from all fish except sturgeon, suckers, and goldeye. Otoliths were taken from walleye, sauger, burbot and whitefish; cleithra were taken from northern pike; the leading fin ray of the pelvic fin and pectoral fin were taken from suckers and sturgeon, respectively; and the operculum was taken from goldeye.

Stomach contents of walleye, sauger, pike, burbot, and whitefish were examined in the field and the percent volume of food items was estimated. Goldeye stomachs were preserved in 10% formalin for later analysis in the lab. Stomach contents of suckers were not examined as these fish ingest fine particulate matter which makes analysis difficult (Pipe 1982).

Seine hauls were conducted along the shores and sandbars of the South Saskatchewan River on each sampling date to provide a quantitative assessment of the species of fingerlings and small forage fish present. Fish captured in the seine were identified according to species, enumerated, and released. If field identification was questionable, the fish were preserved in a 10% formalin solution for later identification in the lab.

In the course of the summer sampling program samples of walleye, northern pike, goldeye and sauger were collected and frozen for tissue analysis. Flesh samples from three walleye from each of the 5 river sampling sites were submitted to the Water Quality Branch, Environment Canada for metal analyses including cadmium, chromium, nickel, copper, lead, zinc, mercury, arsenic and selenium.

Additional specimens of each of the above species were submitted to the Provincial Laboratory for mercury analysis. Also included in the mercury analysis were 10 walleye from Dellwood Reservoir and 7 northern pike from Broderick Reservoir.

## 3.3 HABITAT

Stream habitat around each sampling location was examined on each sampling date in an attempt to identify areas critical for spawning and rearing of fish (particularly walleye). Initially, spawning areas were to be determined by locating fish on their spawning grounds and/or through the location of eggs and fry. This was not successful due to the lack of sufficient water in many tributary streams. However, preferred spawning sites are well documented in the literature and an assessment of probable spawning areas was conducted based upon such available information.

Rearing habitat was determined by locating fingerlings through seining.

## 3.4 RESERVOIRS

In addition to the work on the South Saskatchewan River, this study included an examination of the fishery resources of the reservoirs on Swift Current Creek (Fig. 3) and the Saskatoon Southeast Water Supply System (Fig. 4). The study areas on Swift Current Creek are as follows:

1. Duncairn Reservoir (Reid Lake)
2. Swift Current Reservoir
3. Swift Current Creek at its juncture with Lake Diefenbaker

The Saskatoon Southeast Water Supply System has 6 reservoirs:

1. Broderick
2. Brightwater
3. Blackstrap
4. Bradwell
5. Zelma
6. Dellwood

An inventory of fish and benthic fauna was undertaken at each of these locations following the procedures described above. Quarter standard gangs of gillnet were set in each reservoir and at the mouth of Swift Current Creek to assess the numbers and diversity of larger fish. Minnows and fingerlings were sampled by seining.

Macroinvertebrate fauna was sampled in the reservoirs using an Ekman dredge sampler. Because of time constraints only four samples per reservoir were taken, representing the generally shallow uniform profile of the reservoir basin.

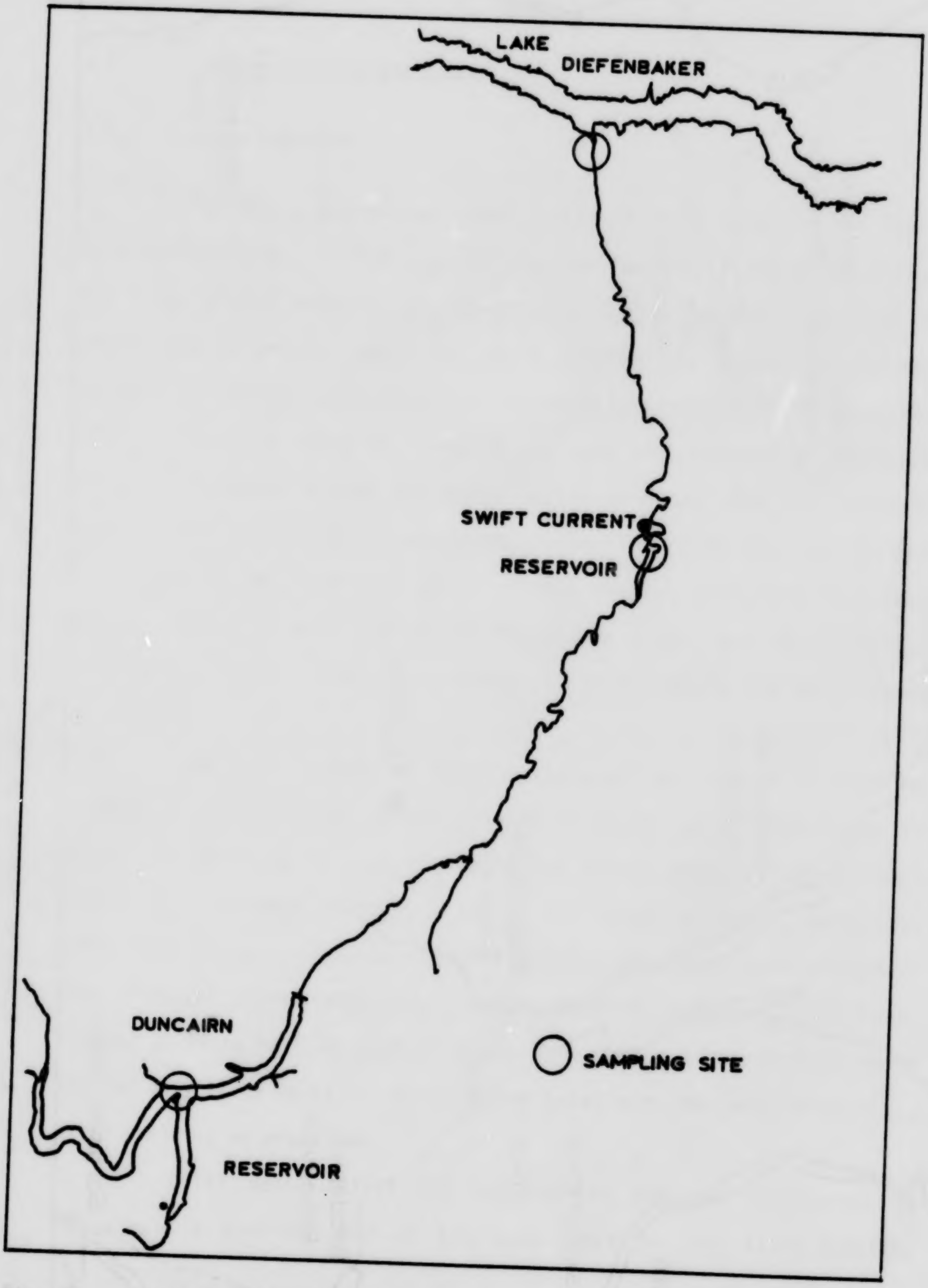


Fig. 3. Schematic diagram of location of sample sites in the Swift Current Creek system.

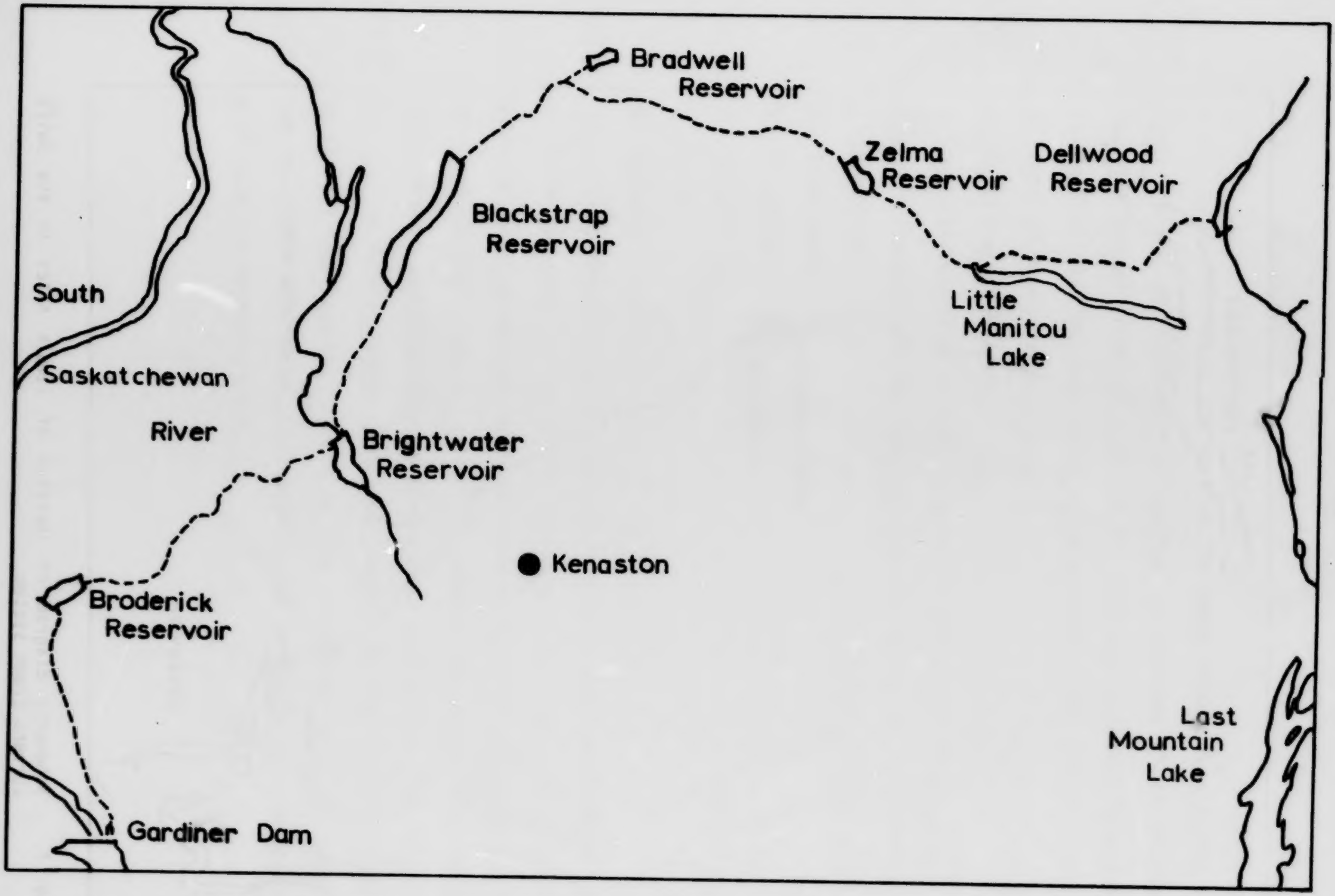


Fig. 4. Schematic diagram of the locations of the reservoirs in the Saskatoon Southeast Water Supply System. (Adapted from Royer, 1970)

# 4. RESULTS

## 4.1 SOUTH SASKATCHEWAN RIVER

### 4.1.1 Invertebrates

Benthic invertebrate fauna collected at 5 sites in the South Saskatchewan River in 1988 are detailed in Appendix 2 (Petersen dredge and Ekman dredge samples) and Appendix 3 (Surber samples). A list of common and scientific names for major invertebrate groups is provided in Table 1. Sludge worms comprised the largest single group of organisms (39%) collected by dredging (Table 2) and were most abundant at Clarkboro Ferry. Freshwater shrimp and midge larvae were the next two dominant groups, contributing 22.7% and 22.5%, respectively, to the total catch. Freshwater shrimp comprised 34.3% of the samples collected by Surber sampler (Table 2) and, similar to the sludge worms, were most numerous at Clarkboro Ferry. Caddisflies ranked second in numbers (24.3%) followed by mayflies at 13%.

The total number of benthic organisms was $1544 \cdot m^{-2}$. Standing biomass of invertebrates ranged from 2.74 $kg.ha^{-}$ at Estuary Ferry to 25.93 and 25.90 $kg.ha^{-1}$ at Clarkboro and Fenton ferries, respectively (Table 3). Average standing biomass was 16.22 $kg.ha^{-1}$. Substrates consisting of mud, clay and/or detritus were generally more productive than rock and gravel materials. Grab samples of soft substrate types, yielded 31.24 $kg.ha^{-1}$ as opposed to the hard bottom Surber samples which yielded only 11.69 $kg.ha^{-1}$. Sandy bottom types were the least productive, often yielding no organisms.

Drift nets, unlike the two benthic sampling techniques, do not sample a discrete area of substrate. Rather, they allow sampling

Table 1: Common names of invertebrates collected by dredge and Surber sampler in the South Saskatchewan River in 1988.

| Common Name | Scientific Name |
|---|---|
| Mayflies | Ephemeroptera |
| Caddisflies | Trichoptera |
| Flies[1] | Diptera |
| Beetles | Coleoptera |
| Dragonflies | Odonata |
| Bugs | Hemiptera |
| Stoneflies | Plecoptera |
| Freshwater Shrimp | Amphipoda |
| Crayfish | Decapoda |
| Snails | Gastropoda |
| Sludge worms | Oligochaeta |
| Leeches | Hirudinea |
| Fingernail Clams | Sphaeriidae |
| Water Fleas | Cladocera |
| Copepods | Copepoda |

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[1] - Predominantly midges or Chironomidae

Table 2: Distribution of benthic fauna (per sample) sampled at 5 sites in the South Saskatchewan River in 1988.

| | Estuary Ferry | | Gardiner Dam$^2$ | | Yorath Island | | Clarkboro Ferry | | Fenton Ferry | | % of Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Surber | Dredge | Surber | Dredge | Surber | Dredge | Surber | Dredge | Surber | Dredge | Surber | Dredge |
| Ephemeroptera | 5.48 | 1.40 | - | 0.15 | 13.81 | 5.12 | 13.84 | 4.86 | 26.00 | 7.00 | 13.0 | 5.0 |
| Trichoptera | 7.04 | 0.04 | - | - | 14.62 | 3.74 | 30.53 | 4.95 | 58.25 | 0.54 | 24.3 | 2.4 |
| Diptera$^1$ | 6.17 | 2.48 | 3.21 | 28.79 | 1.81 | 3.60 | 9.05 | 26.09 | 11.58 | 12.7 | 6.7 | 22.5 |
| Coleoptera | 0.04 | 0.04 | 0.21 | 0.03 | - | - | 0.11 | 0.27 | - | 0.04 | <0.1 | 0.1 |
| Odonata | 0.30 | 0.04 | - | - | 0.14 | 0.04 | 2.53 | 0.27 | 0.17 | 0.75 | 0.6 | 0.3 |
| Hemiptera | - | - | - | 0.03 | - | - | 3.32 | 1.14 | 0.96 | 0.04 | 0.8 | 0.3 |
| Plecoptera | 0.17 | - | - | 0.03 | 0.05 | - | - | 0.05 | 0.08 | 0.46 | <0.1 | 0.1 |
| Amphipoda | 0.04 | - | 0.07 | 1.21 | 0.62 | 0.20 | 161 | 68.36 | 15.79 | 18.75 | 34.3 | 22.7 |
| Decapoda | - | - | - | - | 1.57 | 0.56 | 0.16 | - | 0.50 | 0.13 | 0.5 | 0.2 |
| Gastropoda | 0.04 | - | - | 0.09 | - | - | 27.05 | 8.59 | 4.50 | 2.54 | 6.2 | 2.9 |
| Oligochaeta | 0.87 | - | 18.85 | 4.00 | 0.81 | 8.24 | 22.10 | 87.09 | 5.20 | 49.67 | 8.4 | 39.1 |
| Hirudinae | - | 0.04 | - | 0.27 | - | - | 0.16 | 0.05 | - | - | <0.1 | 0.1 |
| Sphaeriidae | 0.39 | 0.04 | - | 0.79 | 5.62 | 3.96 | 15.16 | 1.68 | 4.13 | 6.83 | 5.1 | 3.7 |
| Total no. organisms | 20.54 | 5.84 | 22.35 | 35.39 | 39.05 | 25.48 | 285.00 | 203.4 | 127.17 | 99.46 | | |
| No. samples | 23 | 25 | 14 | 33 | 21 | 25 | 19 | 22 | 24 | 24 | | |
| Dry weight kg, ha$^{-1}$ | 3.12 | 1.24 | 0.31 | 7.97 | 13.12 | 53.35 | 25.53 | 46.01 | 18.31 | 57.93 | | |

1 - 98% comprised of Chironomidae

2 - Site subject to extreme daily water level fluctuation.

Table 3: Standing crop of organisms (kg dry wt. $ha^{-1}$) collected by Petersen and Ekman dredge at 5 sites on the South Saskatchewan River.

| | No. Samples | North Shore | South Shore | Middle | Average |
|---|---|---|---|---|---|
| Estuary Ferry | 48 | 1.63 | 4.05 | - | 2.74 |
| Gardiner Dam | 47 | 0.43 | 0.27 | 12.23 | 3.05 |
| Yorath Island | 46 | 21.44 | 22.61 | - | 21.96 |
| Clarkboro Ferry | 41 | 28.40 | 23.25 | - | 25.93 |
| Fenton Ferry | 48 | 31.10 | 20.69 | - | 25.90 |

of organisms which swim freely or drift in the water column. No such organisms were collected at Estuary and Fenton ferries (Table 4). The greatest diversity of organisms was found at Clarkboro Ferry where freshwater shrimp comprised almost half (49%) of the total catch. Samples collected from Gardiner Dam were dominated by copepods (90.7%). Drift density was highly variable among the 3 sites that yielded any form of sample and ranged from 1.43 organisms/100m$^3$ at Yorath Island to 2815 organisms/100m$^3$ at Gardiner Dam.

Sweep nets were used at Yorath Island on 19 May and at Clarkboro Ferry on 16 June to sample organisms in thick shoreline vegetation. A list of organisms collected is shown in Appendix 4. Snails were the most abundant group collected at Clarkboro Ferry. At Yorath Island, mayflies, particularly, the families Siphlonuridae and Heptageniidae were prevalent.

### 4.1.2 Fish Species

A combined total of 27 species were collected by gillnetting and seining in the South Saskatchewan River in 1988. A list of common and scientific names of these fish is given in Table 5.

A total of 672 fish, comprising 16 species, were caught in gillnets. Almost half (49%) of this catch was obtained just below Gardiner Dam (Fig. 5); only 6% was captured at Yorath Island. Fishing effort at all sites was approximately equal except at the Gardiner Dam site (Table 6). Here only 2 nets were set per visit, due to the large catch per unit effort, as opposed to the 3 or 4 nets set at the other 4 sites. Gardiner Dam also yielded the greatest species diversity with 13 species (Table 7). Estuary Ferry followed with 11 species. Fenton

Table 4: Summary of invertebrate fauna collected by drift nets at 5 sites in the South Saskatchewan River in 1988.

| | Estuary Ferry | | Gardiner Dam | | Yorath Island | | Clarkboro Ferry | | Fenton Ferry | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total | % | Total | % | Total | % | Total | % | Total | % |
| Ephemeroptera | - | - | - | - | 2 | 100 | 26 | 7.4 | - | - |
| Trichoptera | - | - | - | - | - | - | 3 | 0.9 | - | - |
| Diptera | - | - | 38 | 3.0 | - | - | 27 | 7.7 | - | - |
| Coleoptera | - | - | - | - | - | - | 7 | 2.0 | - | - |
| Odonata | - | - | - | - | - | - | 3 | 0.9 | - | - |
| Hemiptera | - | - | - | - | - | - | 68 | 19.4 | - | - |
| Plecoptera | - | - | 1 | <0.1 | - | - | - | - | - | - |
| Amphipoda | - | - | - | - | - | - | 173 | 49.4 | - | - |
| Decapoda | - | - | - | - | - | - | - | - | - | - |
| Gastropoda | - | - | - | - | - | - | 43 | 12.3 | - | - |
| Cladocera | - | - | 81 | 6.3 | - | - | - | - | - | - |
| Copepoda | - | - | 1168 | 90.7 | - | - | - | - | - | - |
| Total no. organisms | 0 | | 1288 | | 2 | | 350 | | 0 | |
| No. samples | 8 | | 8 | | 7 | | 8 | | 8 | |
| Mean sample drift density/100m $^3$.hr$^{-1}$ | 0 | | 2815 | | 143 | | 239 | | 0 | |

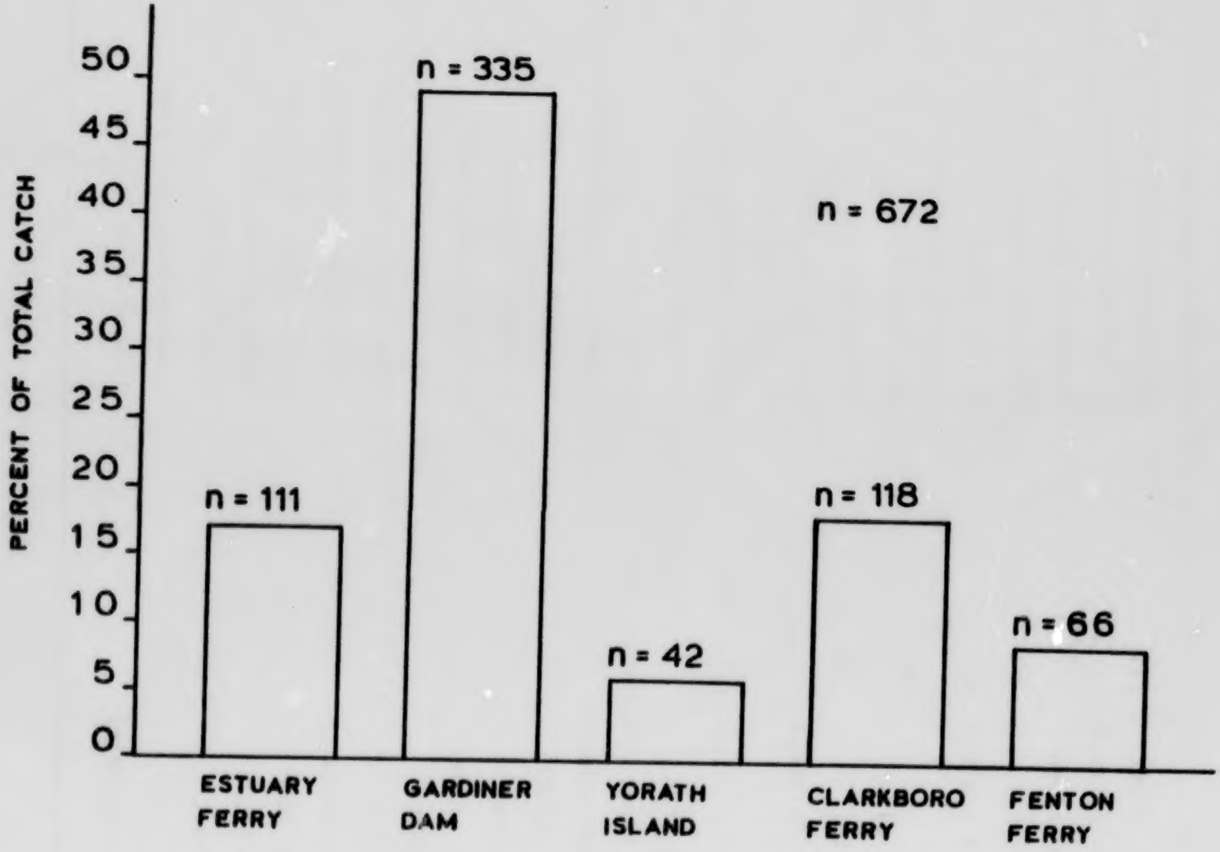


Fig. 5. Catch distribution among 5 sites on the South Saskatchewan River in 1988.

Table 5: Fish species collected by gillnetting and seining in the South Saskatchewan River in 1988.

| Common Name | Scientific Name |
|---|---|
| Lake sturgeon | *Acipenser fulvescens* |
| Quillback | *Carpiodes cyprinus* |
| Longnose sucker | *Catostomus catostomus* |
| Common white sucker | *Catostomus commersoni* |
| Cisco, tullibee | *Coregonus artedii* |
| Lake whitefish | *Coregonus clupeaformis* |
| Spoonhead sculpin | *Cottus ricei* |
| Lake chub | *Couesius plumbeus* |
| Northern pike | *Esox lucius* |
| Iowa darter | *Etheostoma exile* |
| Brook stickleback | *Eucalia inconstans* |
| Goldeye | *Hiodon alosoides* |
| Mooneye | *Hiodon tergisus* |
| Flathead chub | *Hybopsis gracilis* |
| Burbot, ling, freshwater cod | *Lota lota* |
| Shorthead redhorse | *Moxostoma marolepidotum* |
| Emerald shiner | *Notropis atherinoides* |
| River shiner | *Notropis blennius* |
| Spottail shiner | *Notropis hudsonius* |
| Yellow perch | *Perca flavescens* |
| Trout-perch | *Percopsis omiscomaycus* |
| Fathead minnow | *Pimephales promelas* |
| Longnose dace | *Rhinichthys cataractae* |
| Rainbow trout | *Salmo gairdneri* |
| Brook trout | *Salvelinus fontinalis* |
| Sauger | *Stizostedion canadense* |
| Walleye, pickerel | *Stizostedion vitreum* |

Table 6: Fishing effort and catch per unit effort at 5 sites in the South Saskatchewan River in 1988.

| Site | No. Net Sets | No. Fish | Catch/unit effort |
|---|---|---|---|
| Estuary Ferry | 13 | 111 | 8.54 |
| Gardiner Dam | 8 | 335 | 41.88 |
| Yorath Island | 12 | 42 | 3.50 |
| Clarkboro Ferry | 11 | 118 | 10.73 |
| Fenton Ferry | 12 | 66 | 5.5 |
| Total | 56 | 672 | 12.00 |

Table 7: Numbers and total weights (kg) of fish caught in gillnets at 5 sites in the South Saskatchewan River in 1988.

| Species | | Estuary Ferry | | Gardiner Dam | | Yorath Island | | Clarkboro Ferry | | Fenton Ferry | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | % | Total | % | Total | % | Total | % | Total | % | Total | % |
| Burbot | number | -- | -- | 23 | 6.8 | -- | -- | -- | -- | 1 | 1.5 | 24 | 3.6 |
| | weight | -- | -- | 49.7 | 14.3 | -- | -- | -- | -- | 1.3 | 1.8 | 51.0 | 7.6 |
| Cisco | number | -- | -- | 56 | 16.7 | -- | -- | -- | -- | -- | -- | 56 | 8.3 |
| | weight | -- | -- | 2.9 | 0.8 | -- | -- | -- | -- | -- | -- | 2.9 | 0.4 |
| Common white sucker | number | 6 | 5.4 | 48 | 14.3 | 21 | 50.0 | 53 | 44.9 | 21 | 31.8 | 149 | 22.1 |
| | weight | 7.9 | 11.7 | 57.5 | 16.6 | 20.0 | 55.7 | 68.5 | 45.7 | 25.2 | 34.9 | 179.1 | 26.7 |
| Flathead chub | number | 7 | 6.3 | -- | -- | -- | -- | -- | -- | -- | -- | 7 | 1.0 |
| | weight | 0.5 | 0.7 | -- | -- | -- | -- | -- | -- | -- | -- | 0.5 | 0.1 |
| Goldeye | number | 41 | 36.9 | 1 | 0.2 | -- | -- | 2 | 1.7 | 5 | 7.6 | 49 | 7.3 |
| | weight | 13.9 | 20.7 | 0.7 | 0.2 | -- | -- | 1.7 | 1.1 | 4.7 | 6.5 | 21.0 | 3.1 |
| Lake sturgeon | number | 1 | 1.0 | -- | -- | -- | -- | -- | -- | -- | -- | 1 | 0.1 |
| | weight | 2.7 | 4.0 | -- | -- | -- | -- | -- | -- | -- | -- | 2.7 | 0.4 |
| Lake whitefish | number | 1 | 1.0 | 93 | 27.7 | -- | -- | -- | -- | -- | -- | 94 | 14.0 |
| | weight | 1.1 | 1.6 | 77.3 | 22.3 | -- | -- | -- | -- | -- | -- | 78.4 | 11.7 |
| Longnrse sucker | number | 20 | 18.0 | 32 | 9.6 | -- | -- | 28 | 23.7 | 7 | 10.6 | 87 | 12.9 |
| | weight | 20.6 | 30.7 | 33.9 | 9.8 | -- | -- | 30.6 | 20.4 | 5.3 | 7.3 | 90.4 | 13.5 |
| Northern pike | number | 2 | 1.8 | 2 | 0.6 | 8 | 19.0 | 3 | 2.5 | 11 | 16.7 | 26 | 3.9 |
| | weight | 1.2 | 1.8 | 12.0 | 3.5 | 4.7 | 13.1 | 4.3 | 2.9 | 10.8 | 15.0 | 33.0 | 4.9 |
| Quillback | number | 1 | 1.0 | 2 | 0.6 | -- | -- | -- | -- | -- | -- | 3 | 0.4 |
| | weight | 1.2 | 1.8 | 3.0 | 0.9 | -- | -- | -- | -- | -- | -- | 4.2 | 0.6 |
| Rainbow trout | number | -- | -- | 1 | 0.3 | -- | -- | -- | -- | -- | -- | 1 | 0.1 |
| | weight | -- | -- | 0.4 | 0.1 | -- | -- | -- | -- | -- | -- | 0.4 | 0.1 |
| Sauger | number | 7 | 6.3 | -- | -- | -- | -- | 2 | 1.7 | 1 | 1.5 | 10 | 1.4 |
| | weight | 4.7 | 7.0 | -- | -- | -- | -- | 2.1 | 1.4 | 1.3 | 1.8 | 8.1 | 1.2 |
| Shorthead redhorse | number | 10 | 9.0 | 32 | 9.6 | 4 | 9.5 | 22 | 18.6 | 11 | 16.7 | 79 | 11.8 |
| | weight | 4.2 | 6.3 | 37.0 | 10.7 | 5.8 | 16.1 | 28.4 | 19.0 | 15.1 | 20.9 | 90.5 | 13.5 |
| Walleye | number | 15 | 13.5 | 43 | 12.8 | 9 | 21.4 | 8 | 6.8 | 9 | 13.6 | 84 | 12.5 |
| | weight | 9.0 | 13.4 | 72.0 | 20.8 | 5.4 | 15.0 | 14.2 | 9.4 | 8.5 | 11.8 | 109.1 | 16.2 |
| Yellow perch | number | -- | -- | 1 | 0.3 | -- | -- | -- | -- | -- | -- | 1 | 0.1 |
| | weight | -- | -- | 0.02 | 0.0 | -- | -- | -- | -- | -- | -- | | -- |
| Brook trout | number | -- | -- | 1 | 0.3 | -- | -- | -- | -- | -- | -- | 1 | 0.1 |
| | weight | -- | -- | 0.4 | 0.1 | -- | -- | -- | -- | -- | -- | 0.4 | 0.06 |
| Total | number | 111 | | 335 | | 42 | | 118 | | 66 | | 672 | |
| | weight | 67.0 | | 346.82 | | 35.9 | | 149.8 | | 72.2 | | 671.72 | |

and Clarkboro ferries had 8 and 7 species, respectively, and Yorath Island yielded only 4 species.

The common white sucker comprised the largest portion of the total catch both in numbers (22.1%) and weight (26.7%; Table 7) and was the predominant species at Yorath Island, Clarkboro Ferry, and Fenton Ferry. Lake whitefish caught almost exclusively at Gardiner Dam ranked second in numbers, comprising 14% of the total catch, followed by longnose suckers at 13%. Other species captured in the gillnets (in order of abundance) included walleye, shorthead redhorse, cisco, goldeye, northern pike, sauger, flathead chub, and quillback. At Estuary Ferry, goldeye was the species most frequently caught. One lake sturgeon was caught at this site early in the sampling season. Lake whitefish and cisco were the most abundant species at Gardiner Dam. One of each of brook trout, rainbow trout, and yellow perch was also captured at this site. The two species of trout were introduced in a recent stocking program undertaken by the Fisheries Branch.

Of the 16 species captured, only the common white sucker, shorthead redhorse, walleye and northern pike were caught at all 5 sampling sites.

Only a few (2.8%) fish caught in gillnets in May and early June had spawned (Appendix 5). Most (74.2%) were ripe for spawning, while others (23%) showed no sign of reproductive readiness. By mid June, it became increasingly difficult to differentiate among these 3 groups.

Results of seine haul samples from 5 sites along the South Saskatchewan River in 1988 are shown in Table 8. Nineteen species were represented in the total catch. The most diversity was found at Estuary

Table 8: Numbers and relative abundance of small fish caught by seining at 5 sites in the South Saskatchewan River in 1988.

| Species | Estuary Ferry | Gardiner Dam | Yorath Island | Clarkboro Ferry | Fenton Ferry | Total | % |
|---|---|---|---|---|---|---|---|
| Common white sucker | 360 | 710 | 1009 | 3000 | 1860 | 6939 | 51.1 |
| Spottail shiner | 143 | 14 | 711 | 747 | 390 | 2005 | 14.8 |
| Shorthead redhorse | 113 | -- | 12 | 850 | 453 | 1428 | 10.5 |
| River shiner | 804 | 7 | 30 | 1 | 254 | 1096 | 8.1 |
| Fathead minnow | -- | -- | 6 | 155 | 11 | 172 | 1.3 |
| Iowa darter | -- | -- | 122 | -- | -- | 122 | 0.9 |
| Northern pike | 1 | -- | 32 | 17 | 38 | 88 | 0.6 |
| Longnose sucker | 8 | 1 | -- | -- | 75 | 84 | 0.6 |
| Longnose dace | 66 | -- | 8 | -- | 2 | 76 | 0.5 |
| Yellow perch | 2 | -- | 60 | 2 | -- | 64 | 0.4 |
| Trout-perch | 26 | -- | 33 | -- | -- | 59 | 0.4 |
| Brook stickleback | 7 | 26 | 5 | 6 | 2 | 46 | 0.3 |
| Walleye | 10 | -- | 7 | 3 | 5 | 25 | 0.2 |
| Lake chub | 13 | -- | -- | -- | -- | 13 | 0.1 |
| Flathead Chub | 8 | -- | -- | -- | -- | 8 | <0.1 |
| Emerald shiner | 6 | -- | -- | -- | -- | 6 | <0.1 |
| Quillback | 1 | -- | -- | 2 | -- | 3 | <0.1 |
| Mooneye | 1 | -- | -- | -- | -- | 1 | <0.1 |
| Spoonhead sculpin | -- | 4 | -- | -- | -- | 4 | <0.1 |
| Unidentified fry | -- | -- | -- | 600 | 740 | 1340 | 9.9 |
| Total | 1563 | 762 | 2035 | 5383 | 3833 | 13 579 | |
| % | 11.5 | 5.6 | 15.0 | 39.6 | 28.6 | | |

Ferry where 16 species were caught; Gardiner Dam yielded the smallest number of species.

Common white sucker fry made up the largest portion (51.1%) of the small fish captured in the seine net and were found at all 5 sites (Table 8). Spottail shiners, river shiners and brook sticklebacks were as widely distributed but comprised substantially smaller portions of the total catch (14.8%, 8.1%, and 0.3%, respectively). In addition to the 2 above mentioned shiner species, emerald shiners also occurred but in fewer numbers and at the Estuary Ferry site only. In total, shiners contributed to 22.9% of the seine net catch. Shorthead redhorse were caught by seining at all sites except Gardiner Dam and comprised an additional 10.5% of the total catch. Similarly, walleye and northern pike occurred at all sites except Gardiner Dam and their combined numbers comprised less than 1% of the total catch. Fathead minnows occurred at the 3 lowermost sampling stations but were most abundant at Clarkboro Ferry. The remaining 9 species listed in Table 8 comprised a combined total of 5% of the seine net catch.

### 4.1.2.1 Lake Whitefish

Ninety-four lake whitefish were captured using gillnets in the South Saskatchewan River in 1988 and comprised 14% of the total catch (Table 7). All but one of these fish were taken from Gardiner Dam making up 28% of the catch for that site.

The 7.6 cm and 10.2 cm mesh sizes were most effective in catching whitefish providing over 80% of the total whitefish catch. The length-frequency distribution of whitefish is shown in Fig. 6. The fish ranged from 20.5 cm to 48.8 cm in fork length but the major portion

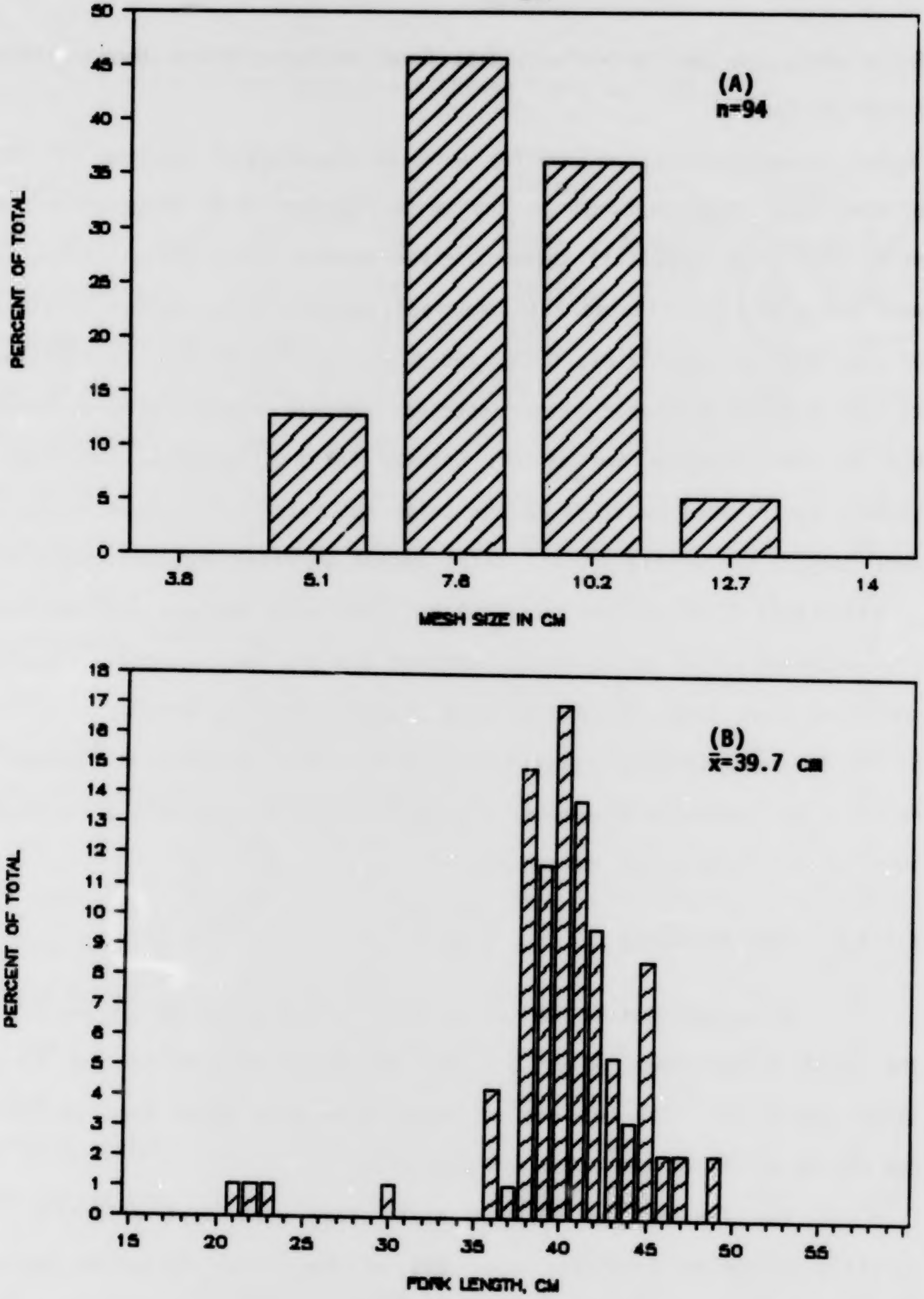


Fig. 6. Distribution of catch in various mesh sizes (A) and length-frequency distribution (B) of lake whitefish caught in gillnets in the South Saskatchewan River in 1988. (n= total number caught; $\bar{x}$=mean fork length).

of the catch was in the 38 to 42 cm range. Average fork length was 39.7 cm; the average weight was 833.2 g (Table 9). The resulting length-weight equation is:

$$W=0.0130L^{2.9925}$$

where W is weight in grams and L is fork length in centimeters. This equation illustrates the length-weight relationship shown in Fig. 7.

Coefficient of condition, K, is an index of relative robustness or well being of a fish, and was calculated based on the formula

$$K=W10^{2}/L^{3}$$

(adapted from Carlander 1969) where W=weight in grams and L is fork length in cm. Condition coefficients were calculated for all fish captured in the gillnets and summarized in Table 10. The condition factor for whitefish was determined to be 1.28 for the 93 fish taken from Gardiner Dam.

Scales and otoliths were collected from whitefish caught in gillnets in 1988 for ageing purposes. Scale ages were used to determine age composition and growth for whitefish whose scale age was 4 years or less. Otoliths were used to age fish showing an older scale age. Scales are often lost and regenerated, providing an unreliable ageing media for older fish. In young fish, however, regeneration of scales is less. Consequently, for young fish, scales tend to be a more reliable ageing media than the otoliths which are often too small to provide an accurate age. The majority of whitefish captured were 5 and 7 years of age, and the oldest whitefish was 15 years (Fig. 8.).

A total of 89 whitefish stomachs were examined for food contents. Plant material made up 39% of the contents in the 72 stomachs containing food (Table 11). Midge larvae (Chironomidae) comprised 31%

Table 9: Summary of length/weight data for fish caught in gillnets in the South Saskatchewan River in 1988.

| Name | Length (cm) | | | Weight (g) | | |
|---|---|---|---|---|---|---|
| | Average | Max. | Min. | Average | Max. | Min. |
| Burbot | 66.6 | 80.8 | 46.5 | 2125.0 | 3400 | 550 |
| Cisco | 29.5 | 38.2 | 19.0 | 270.7 | 650 | 70 |
| Common white sucker | 41.7 | 51.3 | 21.1 | 1196.2 | 2150 | 130 |
| Goldeye | 30.9 | 42.7 | 20.2 | 427.6 | 1100 | 100 |
| Longnose sucker | 42.1 | 50.6 | 16.4 | 1052.2 | 2000 | 40 |
| Northern pike | 49.4 | 92.8 | 21.8 | 1267.6 | 7700 | 60 |
| Shorthead redhorse | 40.2 | 56.8 | 17.2 | 1131.5 | 3050 | 55 |
| Sauger | 36.1 | 51.4 | 19.1 | 545.0 | 1325 | 62 |
| Walleye | 45.8 | 69.2 | 17.3 | 1296.7 | 3550 | 45 |
| Lake whitefish | 39.7 | 48.8 | 20.5 | 833.2 | 1950 | 110 |

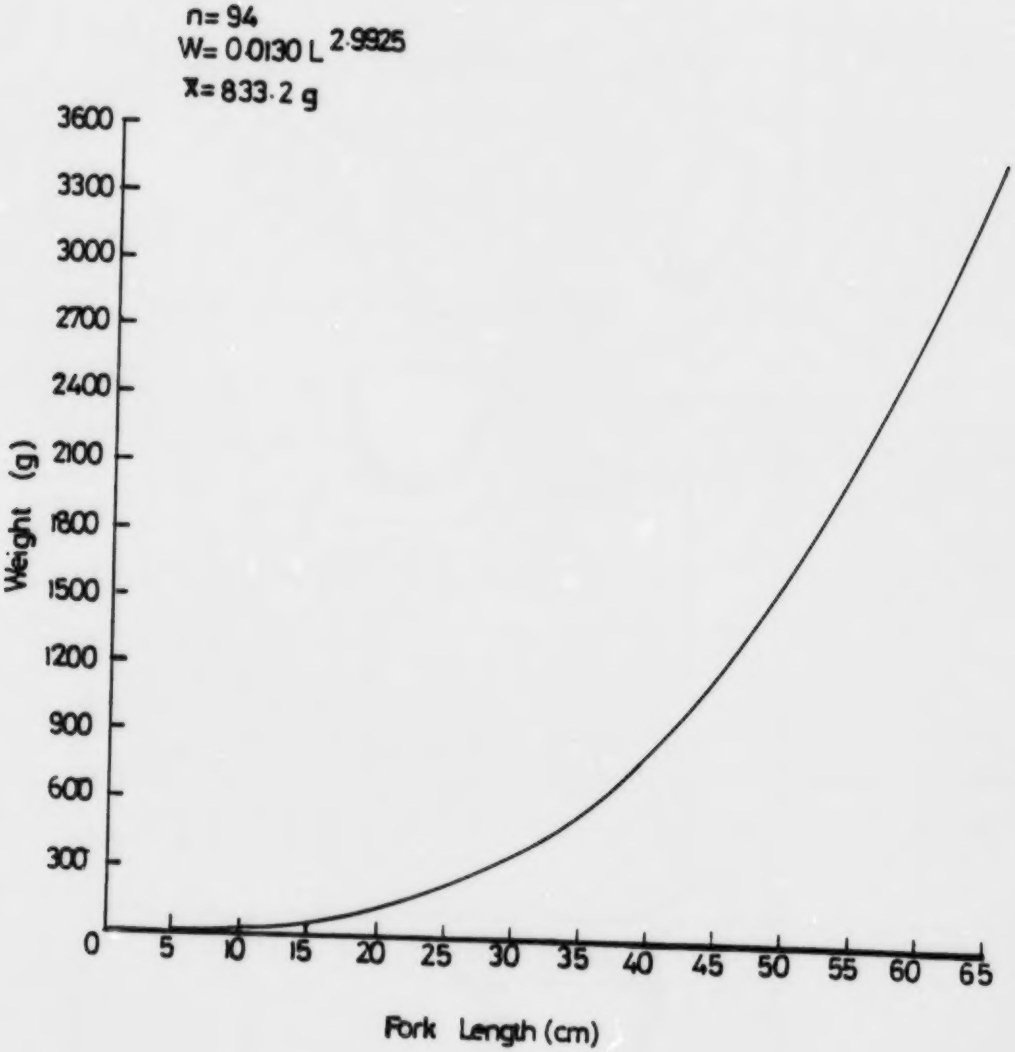


Fig. 7. Length-weight relationship of lake whitefish caught in gillnets in the South Saskatchewan River in 1988. (n=number of fish; $\bar{x}$=mean weight)

Table 10: Coefficients of condition (K) for 16 fish species caught in gillnets at 5 sites in the South Saskatchewan River in 1988.

| Species | Estuary Ferry |  |  | Gardiner Dam |  |  | Yorath Island |  |  | Clarkboro Island |  |  | Fenton Ferry |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | No. | K | SD[1] | No. | K | SD | No. | K | SD | No. | K | SD | No. | K | SD |
| Brook trout | 1 | 0.88 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Burbot | - | - | - | 23 | 0.68 | ±0.08 | - | - | - | - | - | - | 1 | 0.55 | - |
| Cisco | - | - | - | 56 | 1.03 | ±0.01 | - | - | - | - | - | - | - | - | - |
| Common white sucker | 6 | 1.53 | ±0.13 | 48 | 1.54 | ±0.13 | 21 | 1.49 | ±0.11 | 53 | 1.60 | ±0.18 | 21 | 1.53 | ±0.13 |
| Flathead chub | 7 | 1.00 | ±0.44 | - | - | - | - | - | - | - | - | - | - | - | - |
| Goldeye | 41 | 1.33 | ±0.16 | 1 | 1.34 | - | - | - | - | 2 | 1.19 | - | 5 | 1.38 | ±0.10 |
| Lake whitefish | 1 | 1.45 | - | 93 | 1.28 | ±0.12 | - | - | - | - | - | - | - | - | - |
| Longnose sucker | 20 | 1.31 | ±0.18 | 32 | 1.37 | ±0.15 | - | - | - | 28 | 1.30 | ±0.13 | 7 | 1.23 | ±0.08 |
| Northern pike | 2 | 0.63 | - | 2 | 0.86 | - | 8 | 0.71 | ±0.02 | 3 | 0.78 | ±0.07 | 11 | 0.73 | ±0.04 |
| Quillback | 1 | 2.02 | - | 2 | 1.87 | - | - | - | - | - | - | - | - | - | - |
| Shorthead redhorse | 10 | 1.53 | ±0.26 | 32 | 1.62 | ±0.16 | 4 | 1.70 | ±0.08 | 22 | 1.68 | ±0.13 | 11 | 1.63 | ±0.15 |
| Sauger | 7 | 0.86 | ±0.14 | - | - | - | - | - | - | 2 | 1.02 | - | 1 | 1.04 | - |
| Walleye | 15 | 0.90 | ±0.15 | 43 | 1.11 | ±0.09 | 9 | 0.99 | ±0.19 | 8 | 1.08 | ±0.07 | 9 | 1.04 | ±0.08 |
| Yellow perch | - | - | - | 1 | 0.77 | - | - | - | - | - | - | - | - | - | - |

1 - SD - standard deviation

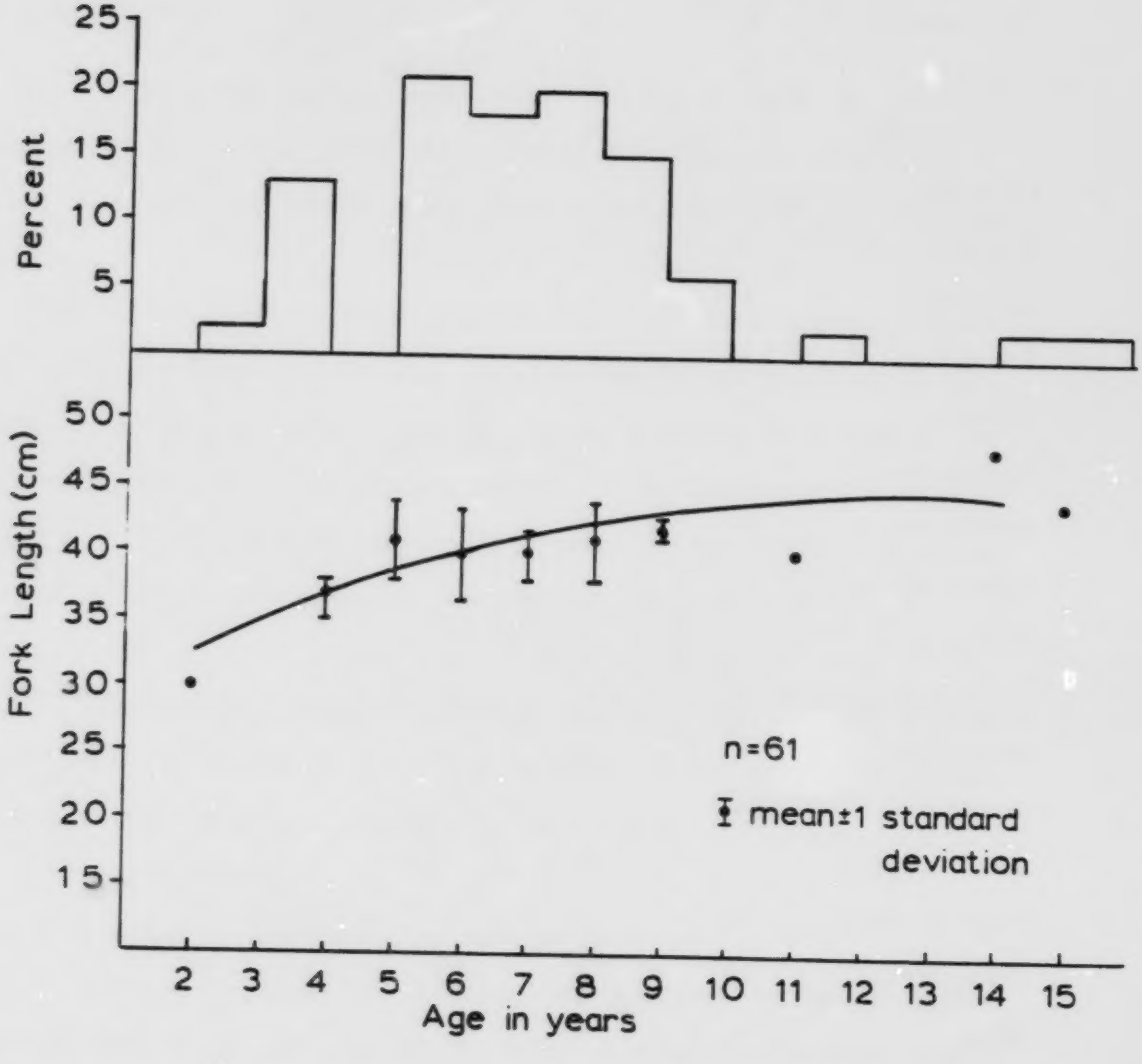


Fig. 8. Age composition and growth of lake whitefish captured in gillnets in the South Saskatchewan River in 1988. (n=number of fish).

Table 11: Occurrence of food items in the stomachs of 6 fish species caught in gillnets in the South Saskatchewan River in 1988. (% composition by volume)

| | Walleye | Whitefish | Northern Pike | Goldeye | Sauger | Burbot |
|---|---|---|---|---|---|---|
| No. Sampled | 84 | 89 | 26 | 48 | 10 | 24 |
| No. with Food | 37 | 72 | 18 | 26 | 2 | 6 |
| Fish remains | 65 | - | 5 | - | 100 | 41 |
| Crayfish | 8 | - | 84 | 6 | - | - |
| Chironomidae | - | 31 | - | - | - | - |
| Corixidae | - | - | - | 5 | - | - |
| Diptera | - | - | - | 4 | - | - |
| Coleoptera | - | - | - | 12 | - | - |
| Plecoptera | - | - | - | 1 | - | - |
| Odonata | - | - | - | 2 | - | - |
| Hymenoptera | - | - | - | 1 | - | - |
| Orthoptera | - | - | - | 1 | - | - |
| Ephemeroptera | - | - | 4 | 7 | - | - |
| Trichoptera | - | - | - | - | - | - |
| Lepidoptera | - | - | - | 1 | - | - |
| Gastropoda | - | 13 | - | - | - | - |
| Amphipoda | 5 | 2 | - | - | - | - |
| Sphaeriidae | - | 6 | - | - | - | - |
| Plant Material | 2 | 39 | - | - | - | - |
| Unidentified | 20 | 8 | - | 61 | - | 59 |
| Other | - | - | 5 | - | - | - |

of the contents and appeared to be the most preferred invertebrate food item. Snails (Gastropods) ranked second, contributing 13% of the content volume. Other food items included freshwater shrimp (Amphipods) (2%), fingernail clams (Sphaeriidae) (6%), blackfly larvae (Simuliidae)(0.1%) and mayfly larvae (Ephemeroptera) (0.2%).

#### 4.1.2.2 Walleye

Eighty-four walleye were caught in the gillnets in 1988 and comprised 12.5% of the total catch (Table 7). Walleye were captured at all 5 sites, but the majority (51%) were taken from the Gardiner Dam site.

The length-frequency distribution for this species, shown in Fig. 9, indicates a wide range of size from 17 cm to 70 cm in fork length. The largest portion of the catch, however, fell within the 40 cm to 55 cm size range, and was caught in the 3.8 cm and 7.6 cm mesh gillnets. It was observed during the course of the study that large fish often become entangled in the smaller mesh apparently while in search of prey.

The average length of walleye was 45.8 cm and the average weight was 1296.7g (Table 9). The relationship of weight to length is shown in Fig. 10 and is described by the equation:

$$W=0.0039L^{3.255}$$

where W is weight in grams and L is fork length in cm.

Walleye captured at Gardiner Dam appeared to be in better condition than those captured at the other 4 sampling locations (Table 10) and had a condition factor of 1.11. Those caught at Estuary Ferry had the lowest condition (K=0.90) suggesting a poorer diet and/or stressed conditions.

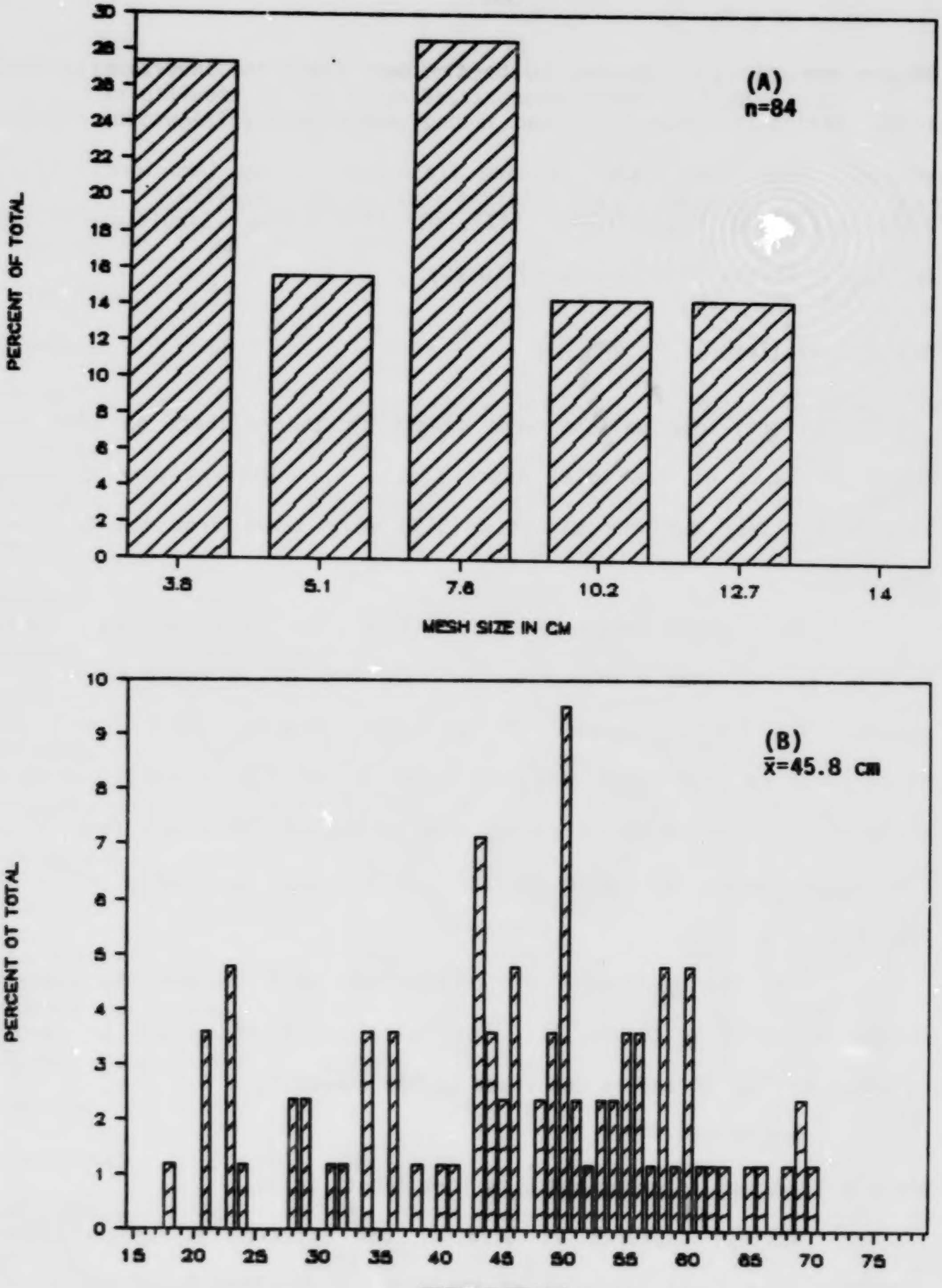


Fig. 9. Distribution of catch in various mesh sizes (A) and length-frequency distribution (B) of walleye caught in gillnets in the South Saskatchewan River in 1988. (n=total number caught; $\bar{x}$=mean fork length).

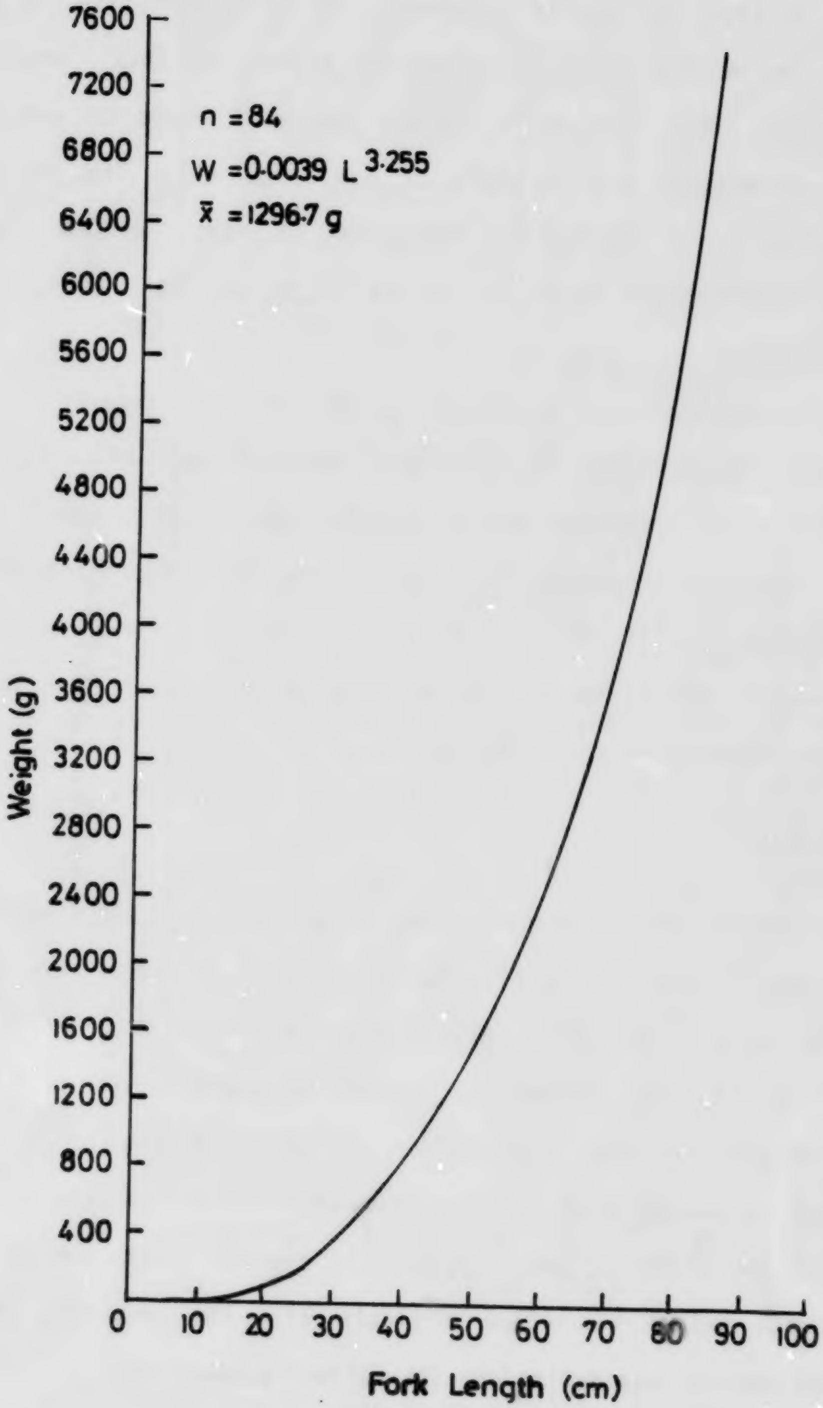


Fig. 10. Length-weight relationship of walleye caught in gillnets in the South Saskatchewan River in 1988. (n=number of fish; $\bar{x}$=mean weight)

Scales and otoliths were collected from most walleye captured in gillnets in 1988 for ageing purposes. As with whitefish, scales were used to age walleye whose scale age was 4 years or less. Otoliths were used to age those fish with a scale age of 5 years or greater. The majority of walleye were 4 years of age (Fig. 11). The youngest fish captured was 1 year old and the oldest was 13 years. Walleye growth in the South Saskatchewan River is fairly rapid up until 5 years of age.

Food contents were examined in 84 walleye stomachs. Fish remains, including common white sucker fingerlings, ciscoes, and unidentified minnows, comprised 65% of the contents of 37 stomachs with food (Table 11). Three stomachs contained crayfish comprising 8% of the total content by volume. One stomach contained freshwater shrimp and mayfly larvae, making up 5%. Plant material comprised 2%. Twenty percent of the contents were unidentifiable.

#### 4.1.2.3 Goldeye

Forty-nine goldeye were captured in gillnets in 1988 comprising 7.3% of the total catch (Table 7). Forty-one (84%) of these were taken from Estuary Ferry. The catch distribution diagram (Fig. 12) shows that almost 70% of this species was caught in gillnets with a 7.6 cm mesh. The length-frequency distribution is shown in Fig. 12 . Sizes ranged from 20.2 cm to 42.7 cm with the majority of goldeye ranging between 25 cm and 30 cm in fork length. The average length was 30.9 cm and the average weight was 427.6 g (Table 9). The resulting weight to length relationship was defined by the following equation:

$$W=0.0248L^{2.8160}$$

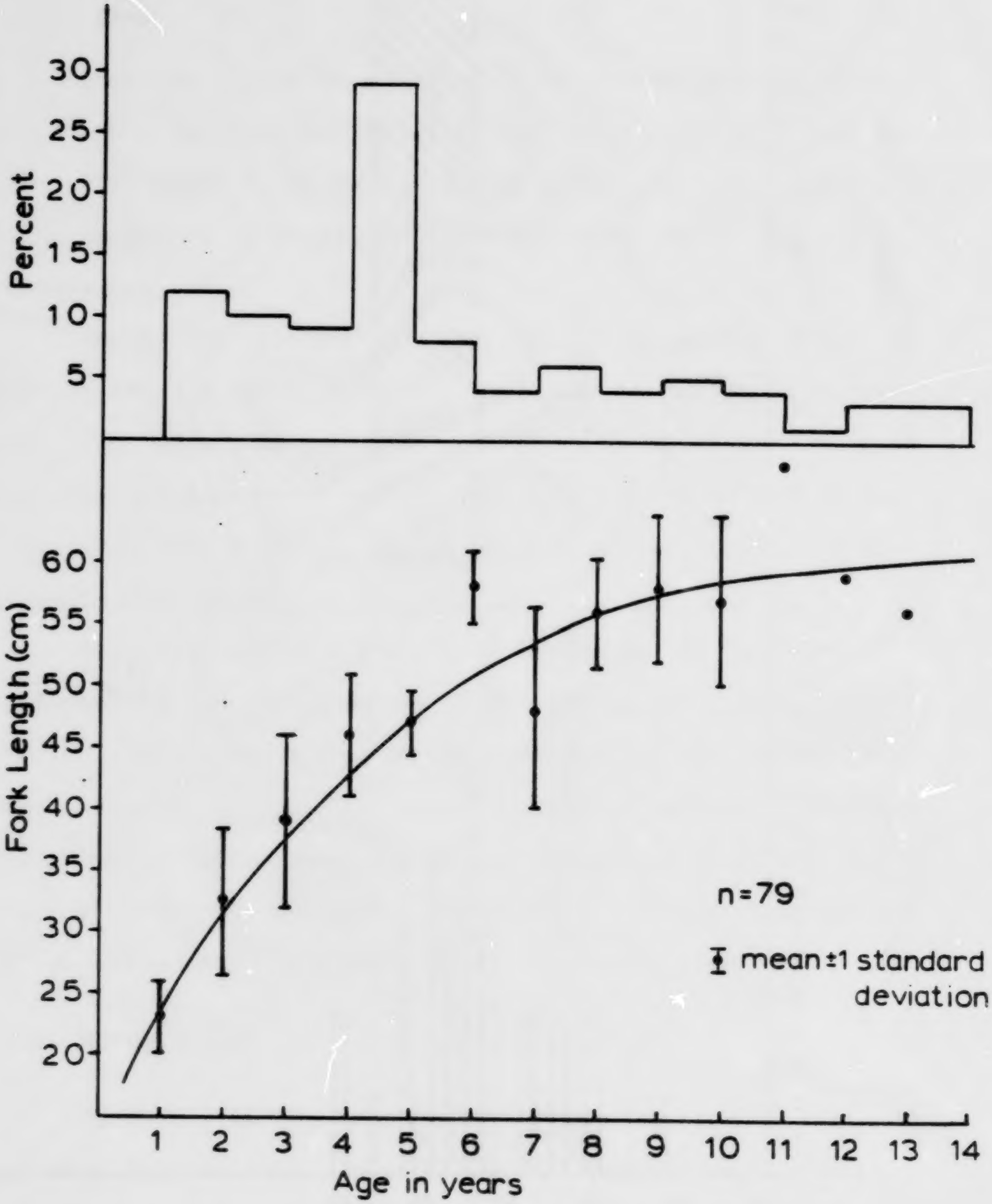
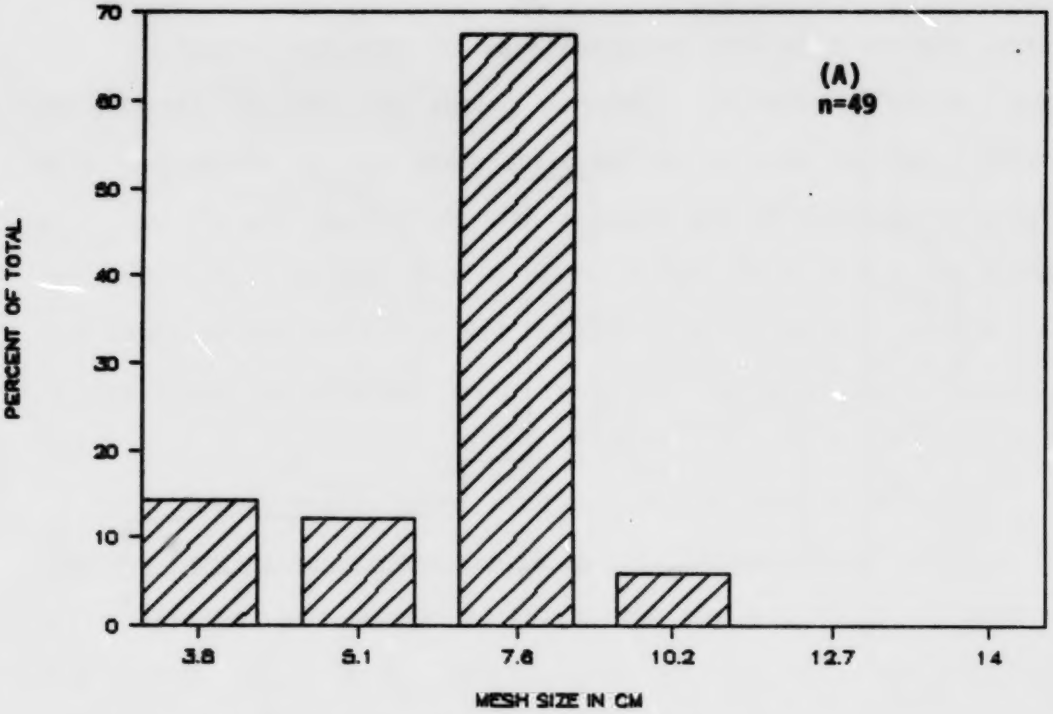


Fig. 11. Age composition and growth of walleye captured in gillnets in the South Saskatchewan River in 1988. (n=number of fish).



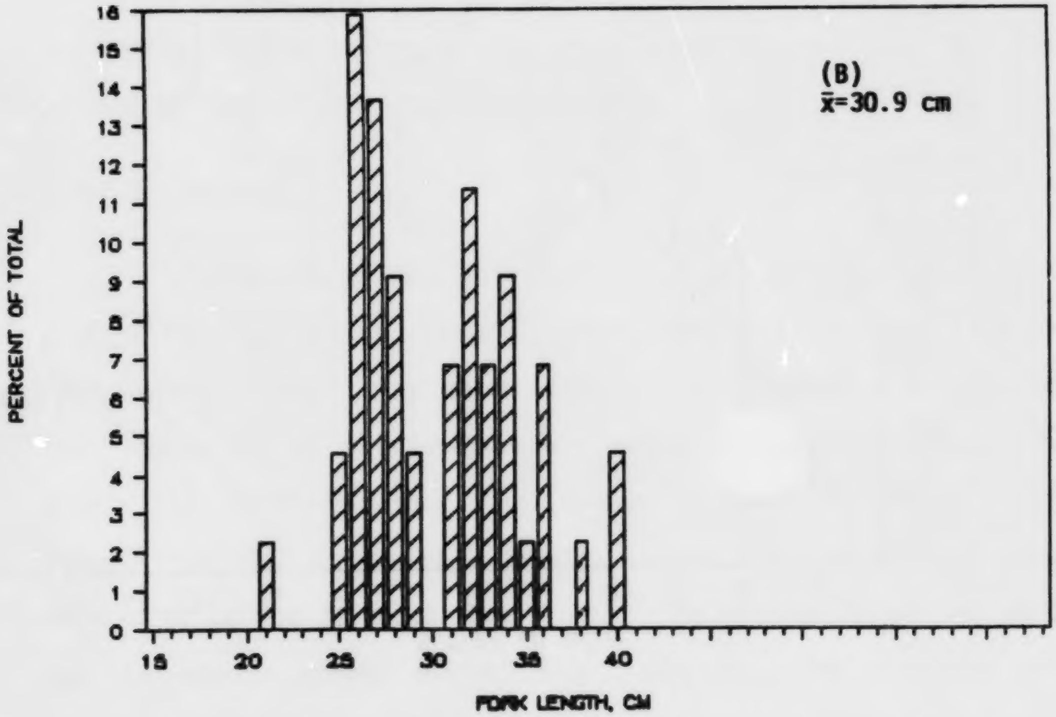


Fig. 12. Distribution of catch in various mesh sizes (A) and length-frequency distribution (B) of goldeye caught in gillnets in the South Saskatchewan River in 1988. (n=total number caught; $\bar{x}$=mean fork length).

where W is weight in grams and L is fork length in centimeters (Fig. 13).

Condition coefficients (Table 10) for goldeye caught at Estuary Ferry (K=1.33), Gardiner Dam (K=1.34), and Fenton Ferry (K=1.38) were similar. Fish caught at Clarkboro Ferry had a lower condition coefficient (K=1.19) suggesting stressed environmental condition or paucity of appropriate food.

Scales and opercula were collected from goldeye caught in gillnets in 1988 for ageing purposes. The scales did not give consistent results. Age composition and growth, based on operculum age are shown in Fig. 14. The majority of goldeye were between 4 and 5 years of age, and the oldest was 14 years. Growth of this species appeared to slow considerably after age 8.

Forty-eight goldeye stomachs were examined for food contents. Insects comprised 34% of the volume of 26 stomachs containing foodstuff (Table 11). Groups encountered included waterboatmen (Corixidae), flies (Diptera), beetles (Coleoptera), stonefly nymphs (Plecoptera), dragonfly nymphs (Odonata), wasps (Hymenoptera), grasshoppers (Orthoptera), mayfly nymphs (Ephemeroptera) and moths (Lepidoptera). Sixty-one percent of the volume was unidentifiable while 6% was comprised of crayfish.

#### 4.1.2.4 Northern Pike

Northern pike were caught at all 5 sampling sites in the South Saskatchewan River in 1988. In total, 26 fish were captured, comprising 3.9% of the total catch (Table 7). Forty-two percent of these were taken from Fenton Ferry. Most northern pike were between 45 cm and 55 cm in fork length (Fig. 15) and the gillnet meshes most effective

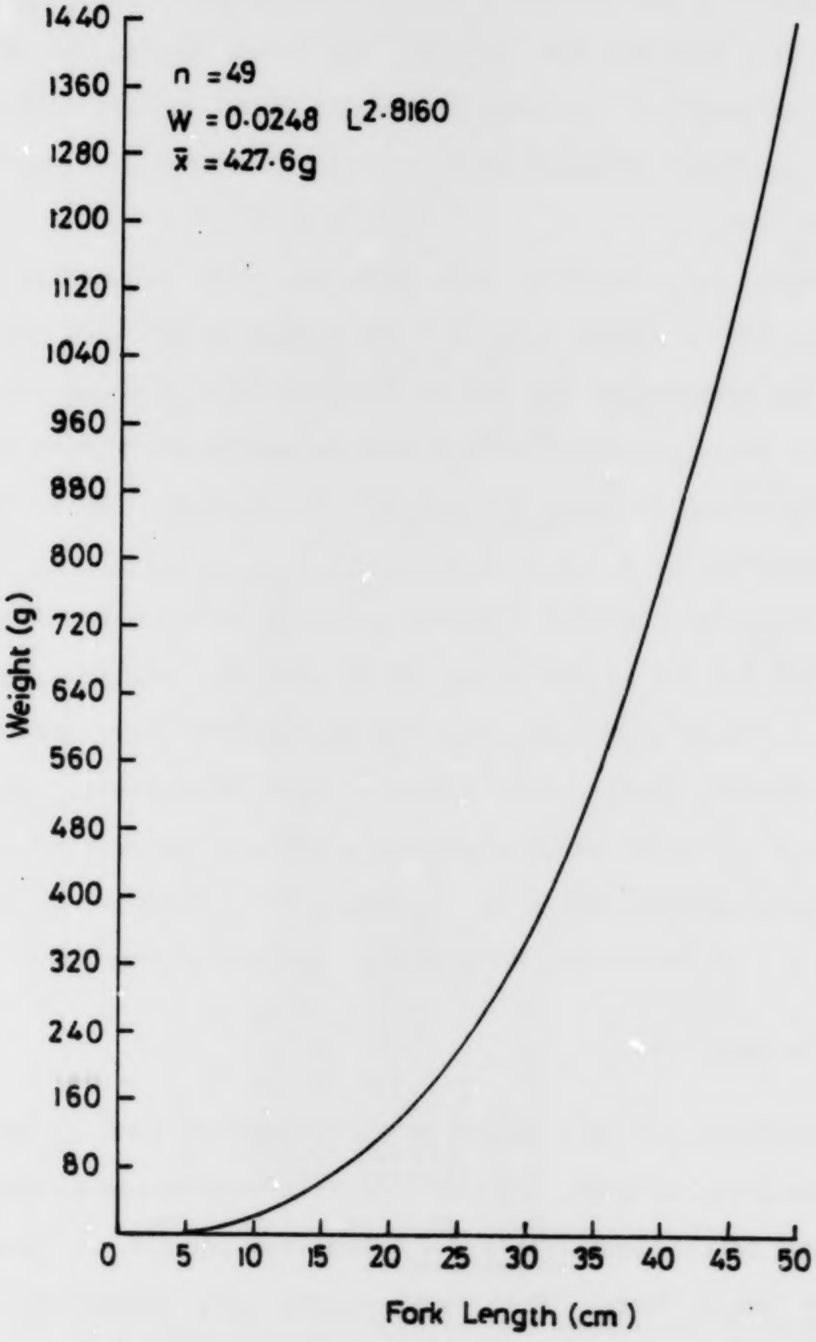


Fig. 13. Length-weight relationship of goldeye caught in gillnets in the South Saskatchewan River in 1988. (n=number of fish; $\bar{x}$=mean weight)

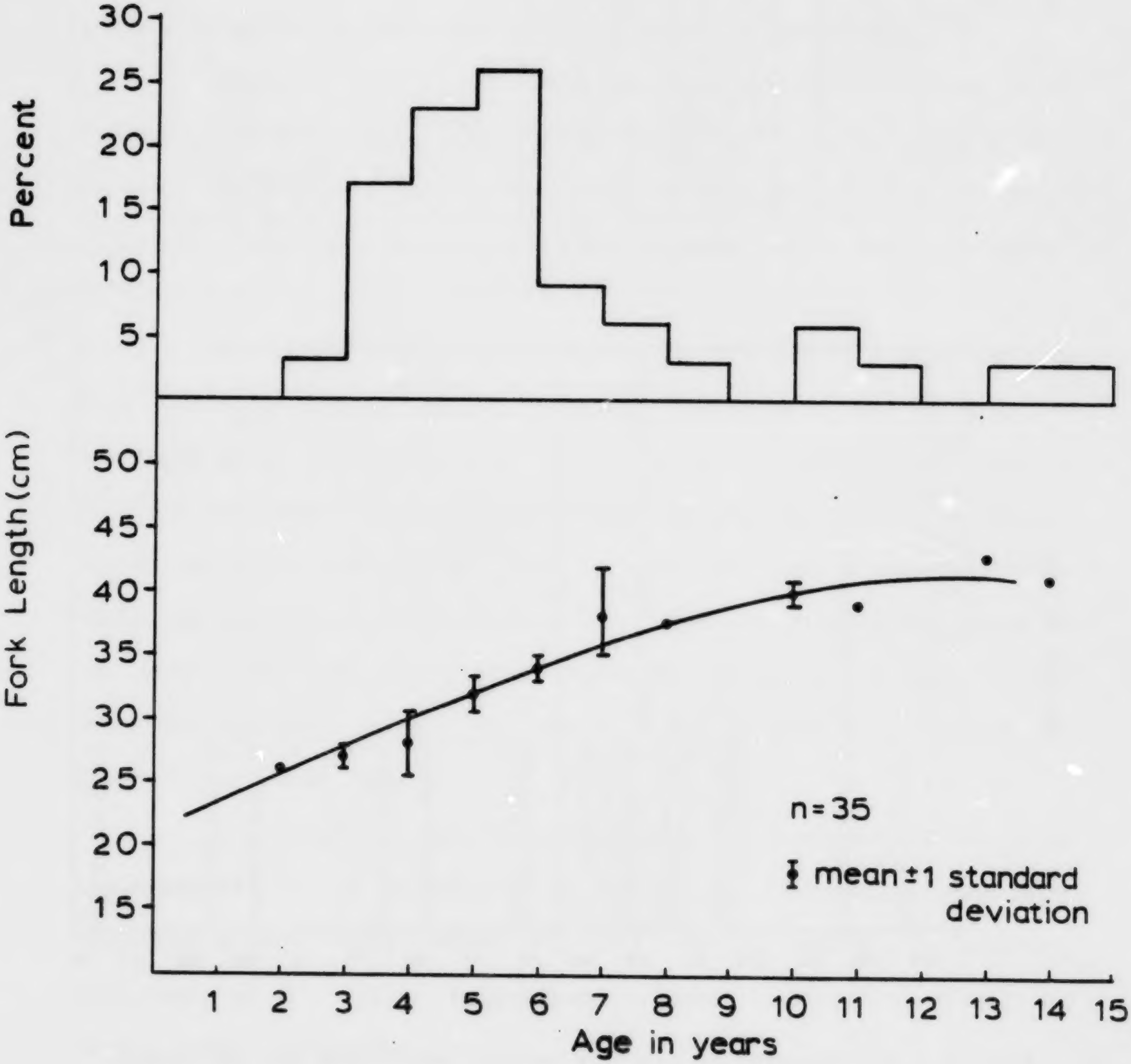


Fig. 14. Age composition and growth of goldeye captured in gillnets in the South Saskatchewan River in 1988. (n=number of fish).

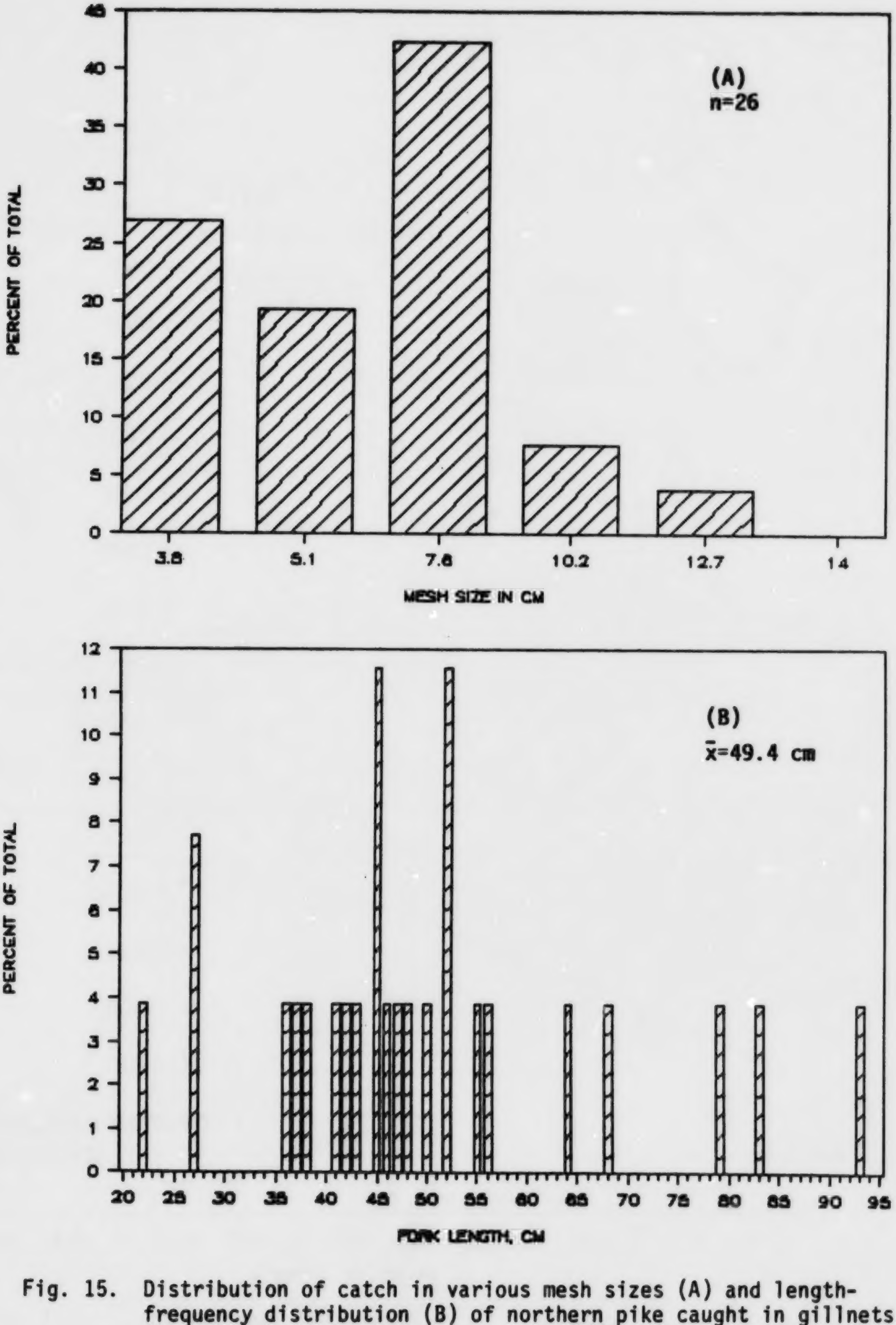


Fig. 15. Distribution of catch in various mesh sizes (A) and length-frequency distribution (B) of northern pike caught in gillnets in the South Saskatchewan River in 1988. (n=total number caught; $\overline{x}$=mean fork length).

in catching these fish tended to be the 3.8 cm and 7.6 cm (Fig. 15). As with the walleye, large pike were often entangled in the smaller mesh apparently while hunting prey.

The average fork length of northern pike was 49.4 cm and the average weight was 1267.6 g (Table 9). The length-weight relationship is shown in Fig. 16 and is described by the equation:

$$W=0.0045L^{3.1208}$$

where W is weight in grams and L is fork length in centimeters.

Condition coefficients calculated for northern pike from Yorath Island, Clarkboro Ferry, and Fenton Ferry were similar (Table 10). Gardiner Dam pike had the highest condition (K=0.86) while those caught at Estuary Ferry had the lowest (K=0.63) suggesting differences in habitat suitable for pike.

Scales and cleithra were collected from northern pike captured in gillnets in 1988 for ageing purposes. Scales were used as an ageing media for those fish 4 years and younger according to scale age. Scales on older specimens were often regenerated and did not provide a reliable ageing media for these fish. The cleithrum was used to age pike whose scale age was 5 years or greater. Most northern pike were 3 years of age (Fig. 17). The oldest fish caught was 12 years but no fish 8-11 years of age were taken. The growth curve suggest this species has a very rapid growth rate.

A total of 26 stomachs were examined for food remains. Crayfish comprised 84% of the volumetric content of the 18 stomachs containing food (Table 11). Fish remains and bird remains, possibly a duckling, each made up 5%. Other food items included leeches (Hirudinea) and mayfly nymphs (Ephemeroptera)

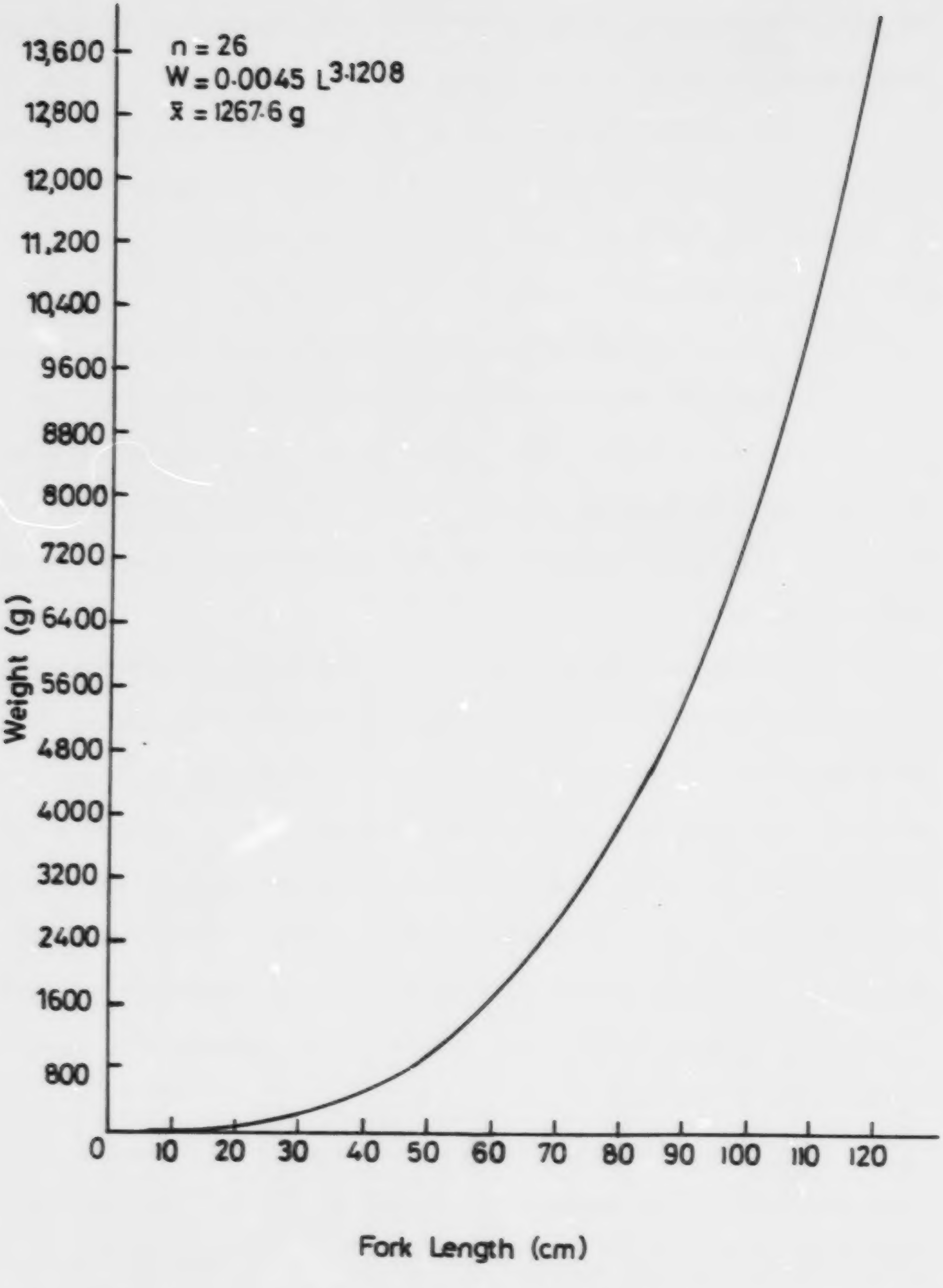


Fig. 16. Length-weight relationship of northern pike caught in gillnets in the South Saskatchewan River in 1988. (n=number of fish; $\bar{x}$=mean weight)

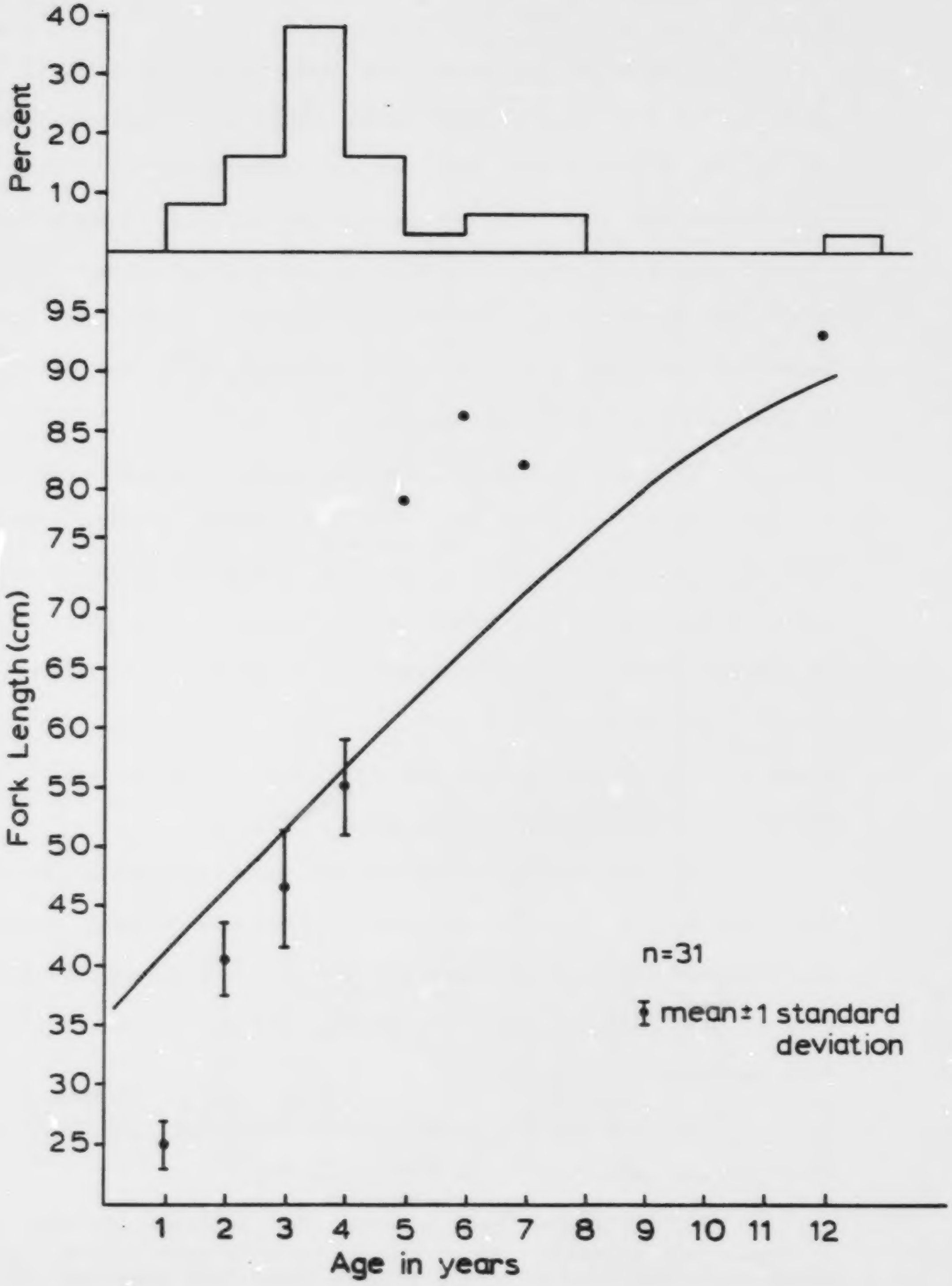


Fig. 17. Age composition and growth of northern pike captured in gillnets in the South Saskatchewan River in 1988. (n=number of fish).

### 4.1.2.5 Burbot

A total of 24 burbot was captured in the gillnets in 1988, constituting 3.6% of the total catch (Table 7). Gardiner Dam yielded 95% of the burbot catch; only one was taken elsewhere. This suggests that either the cool water below the dam is more suitable for burbot or this species is more vulnerable to being drawn through the turbines from Lake Diefenbaker. Burbot are generally distributed throughout Canada, Europe and Asia (Scott and Crossman 1973) and do not appear to have unique habitat requirements.

The 14.0 cm mesh and the 10.2 cm mesh were the most effective in capturing burbot (Fig. 18). The fish ranged in size from 46.5 to 80.8 cm with a mean length of 66.6 cm (Table 9). Fig. 18 shows that approximately 50% of the burbot caught ranged in size from 70 - 80 cm in length. Average weight was determined to be 2125.0 g. The equation

$$W=0.0039L^{3.1290}$$

where W is the weight in grams and L is length in centimeters, illustrates the weight to length relationship shown in Fig. 19.

Age composition and growth of burbot, based on otolith age, are shown in Fig. 20. The majority of fish were 7 and 9 years of age. The youngest fish was 5 years old and the oldest was 15 years. The growth curve suggests that the growth rate of burbot is slow within this age range.

For the 23 fish caught at Gardiner Dam, the coefficient of condition was determined to be 0.68 (Table 10).

All 24 burbot were examined for evidence of food in their stomachs. Material that could not be identified comprised 59% of the contents of the 6 stomachs with food remains (Table 11). Fish, primarily cisco, made up the remaining 41%.

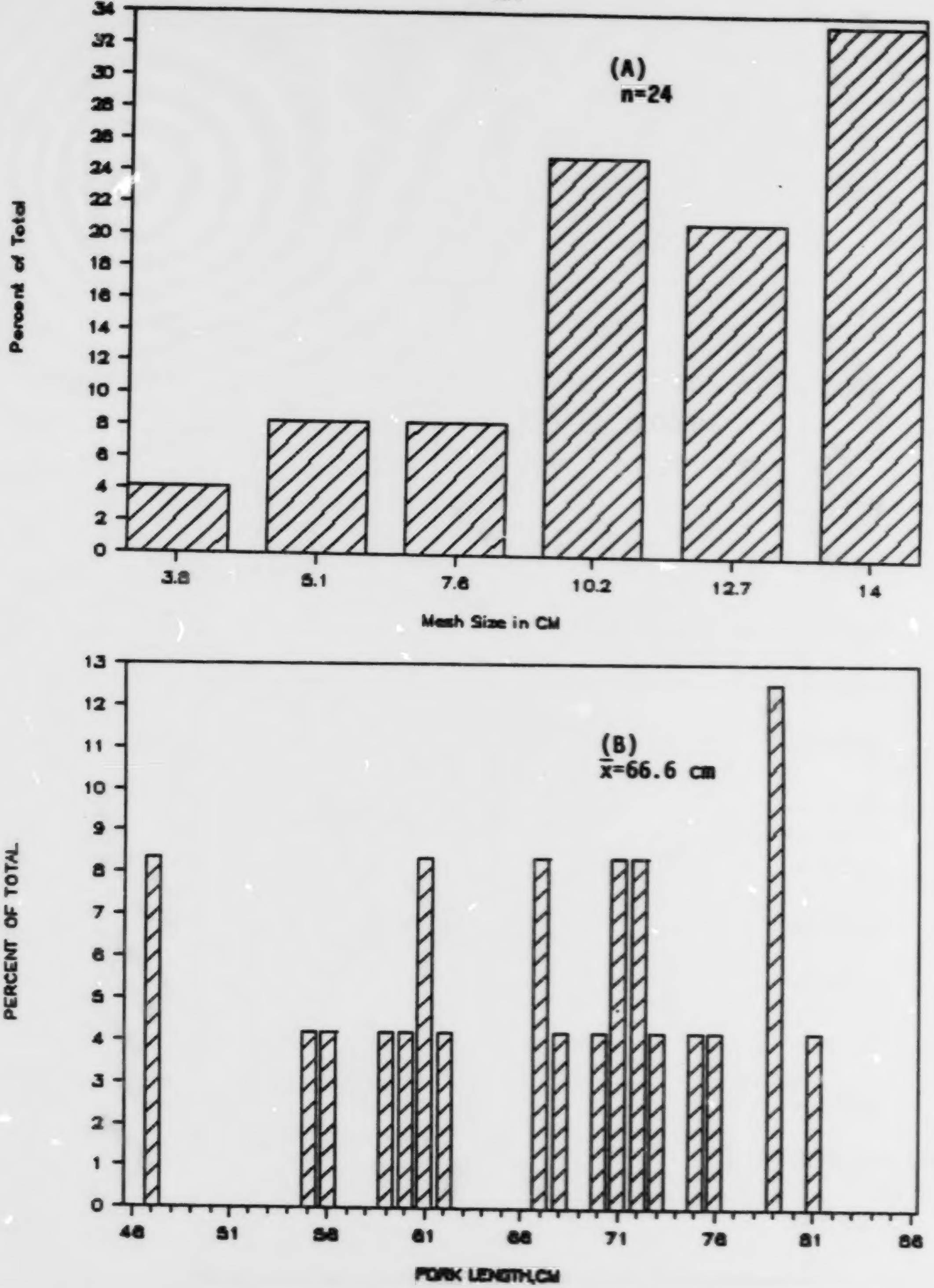


Fig. 18. Distribution of catch in various mesh sizes (A) and length-frequency distribution (B) of burbot caught in gillnets in the South Saskatchewan River in 1988. (n=total number caught; $\bar{x}$=mean fork length).

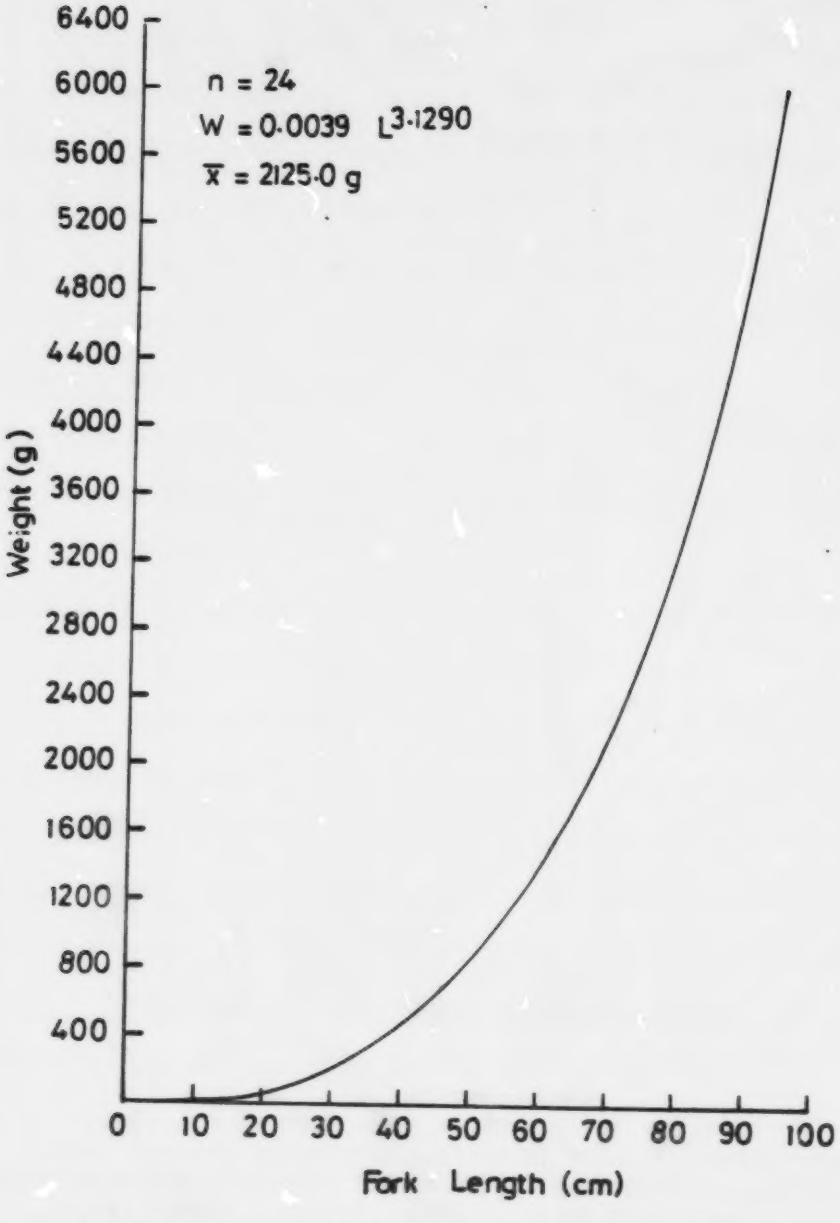


Fig. 19. Length-weight relationship of burbot caught in gillnets in the South Saskatchewan River in 1988. (n=number of fish; $\bar{x}$=mean weight)

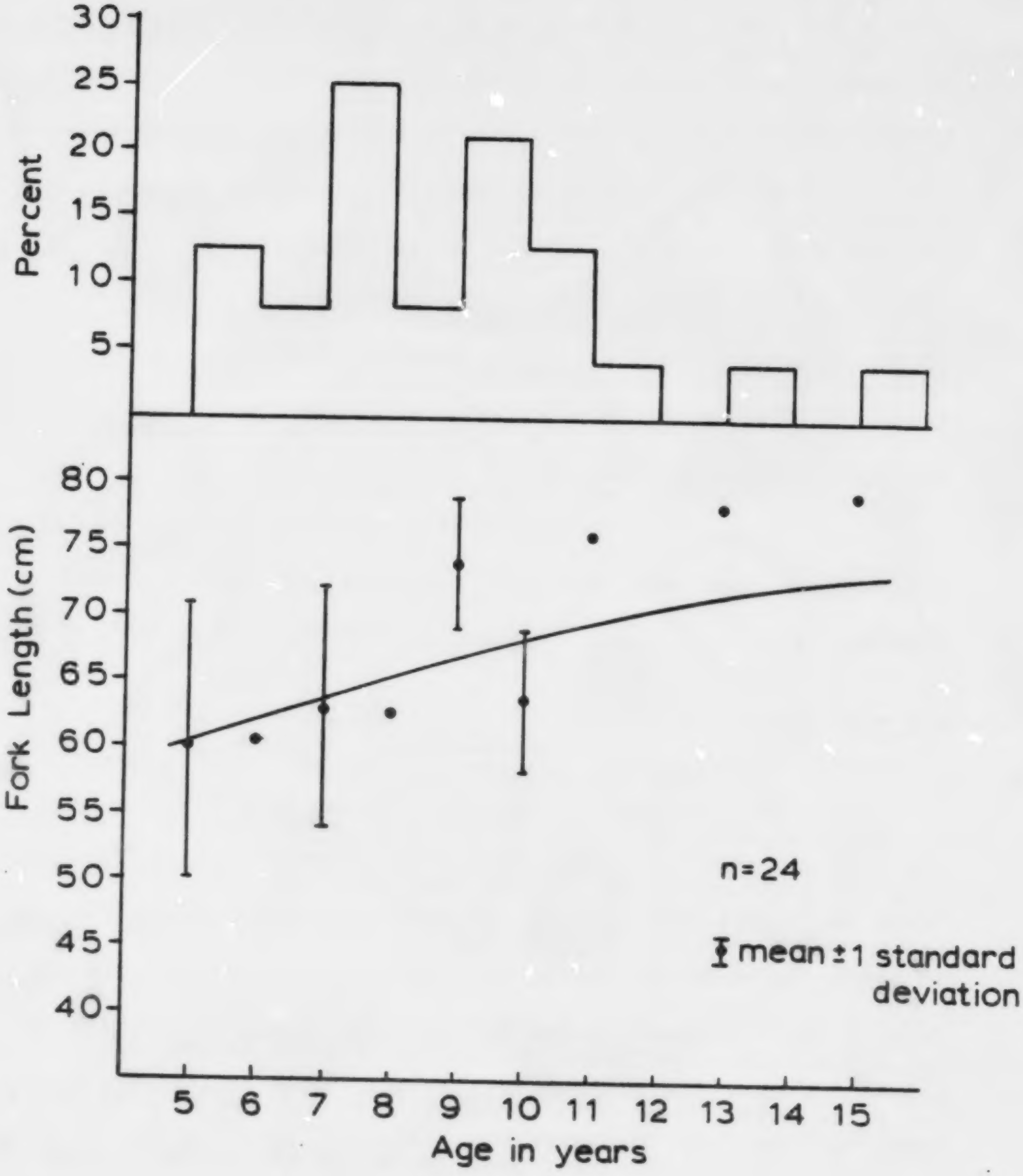


Fig. 20. Age composition and growth of burbot captured in gillnets in the South Saskatchewan River in 1988. (n=number of fish).

### 4.1.2.6 Sauger

Ten sauger were taken in the gillnets in the South Saskatchewan River in 1988, and comprised only 1.4% of the total catch (Table 7). Six of the 10 fish were taken at Estuary Ferry on May 09-10.

Average fork length of sauger was determined to be 36.1 cm with a size range of 19.1 cm to 51.4 cm (Table 9). Insufficient numbers of sauger were caught to establish a reliable length-weight curve. Length, weight, and age data for this species are shown in Appendix 6.

Condition factors of sauger captured at Clarkboro and Fenton ferries were similar; 1.02 and 1.04, respectively (Table 10). Those fish caught at Estuary Ferry had a substantially lower condition factor (0.86) suggesting less available food. Turbid water at this site would appear to provide habitat suitable to sauger (Scott and Crossman 1973) and should not be a stress factor.

All 10 sauger stomachs were examined for food contents. Only 2 contained food and this was comprised of 100% unidentifiable fish remains (Table 11).

### 4.1.2.7 Cisco

Cisco, or lake herring, were caught in gillnets only at Gardiner Dam. These fish are typically a cold water species inhabiting deep lakes and not normally found in river systems although they may occur in large rivers in the Hudson Bay region and westward (Scott and Crossman 1973). Their presence below Gardiner Dam suggests that the cold water provided through the turbines creates a suitable habitat for the specimens escaping from Lake Diefenbaker. The total catch of 56 fish comprised 8.3% of the total catch for the South Saskatchewan River in 1988 (Table

7). The catch distribution (Fig. 21) shows that over 55% of individuals were caught in the 5.1 cm mesh gillnet. The length-frequency distribution diagram (Fig. 21) illustrates that approximately 80% of the fish ranged in size from 28 cm to 32 cm in fork length. Average length was determined to be 29.5 cm (Table 9) with the smallest being 19.0 cm and the largest being 38.2 cm in length. Average weight of ciscoes was 270.7 g. The resulting weight to length relationship is defined by the following equation:

$$W=0.0127L^{2.9366}$$

where W is weight in grams and L is fork length in centimeters, and is shown in Fig. 22.

Scales were collected from cisco captured in gillnets in 1988 for ageing purposes. The majority of ciscoes were 2-3 years of age and the oldest was 4 years (Fig. 23).

The condition factor of ciscoes from Gardiner Dam was determined to be 1.03 (Table 10).

#### 4.1.2.8 Common White Sucker

The common white sucker was the species most frequently captured in gillnets in 1988. It was caught at all 5 sites and comprised 22.1% of the total catch (Table 7). Of the 149 common white suckers caught, 53 (36%) were taken at Clarkboro Ferry. The second largest catch (48 fish) was from the Gardiner Dam site. Only 6 fish were caught at Estuary Ferry.

The meshes most effective in capturing common white suckers were the 10.2 cm and 7.6 cm sizes (Fig. 24). Most common white suckers were between 40 cm and 45 cm in fork length (Fig. 24). Sizes ranged

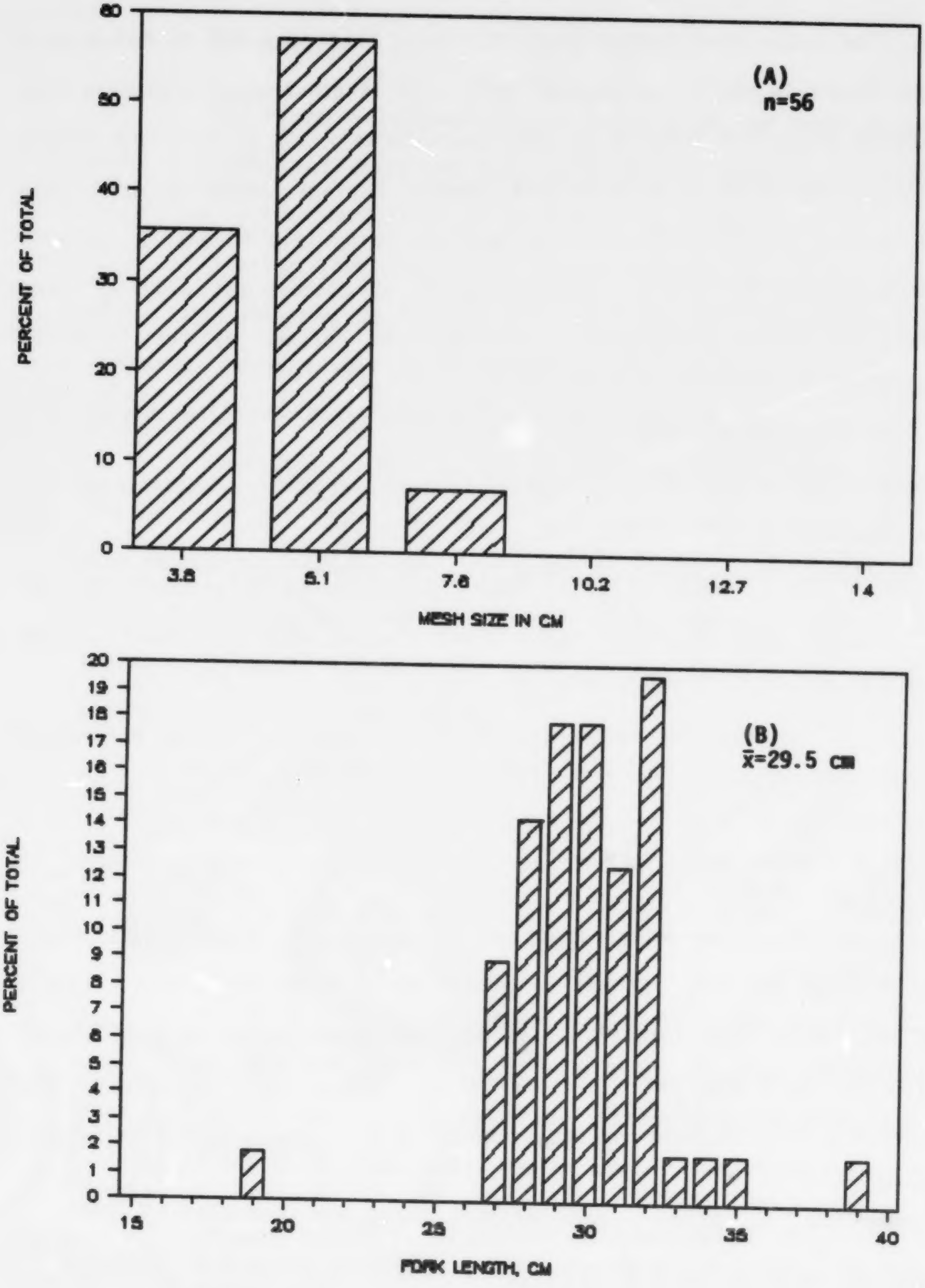


Fig. 21. Distribution of catch in various mesh sizes (A) and length-frequency distribution (B) of cisco caught in gillnets in the South Saskatchewan River in 1988. (n=total number caught; $\bar{x}$=mean fork length).

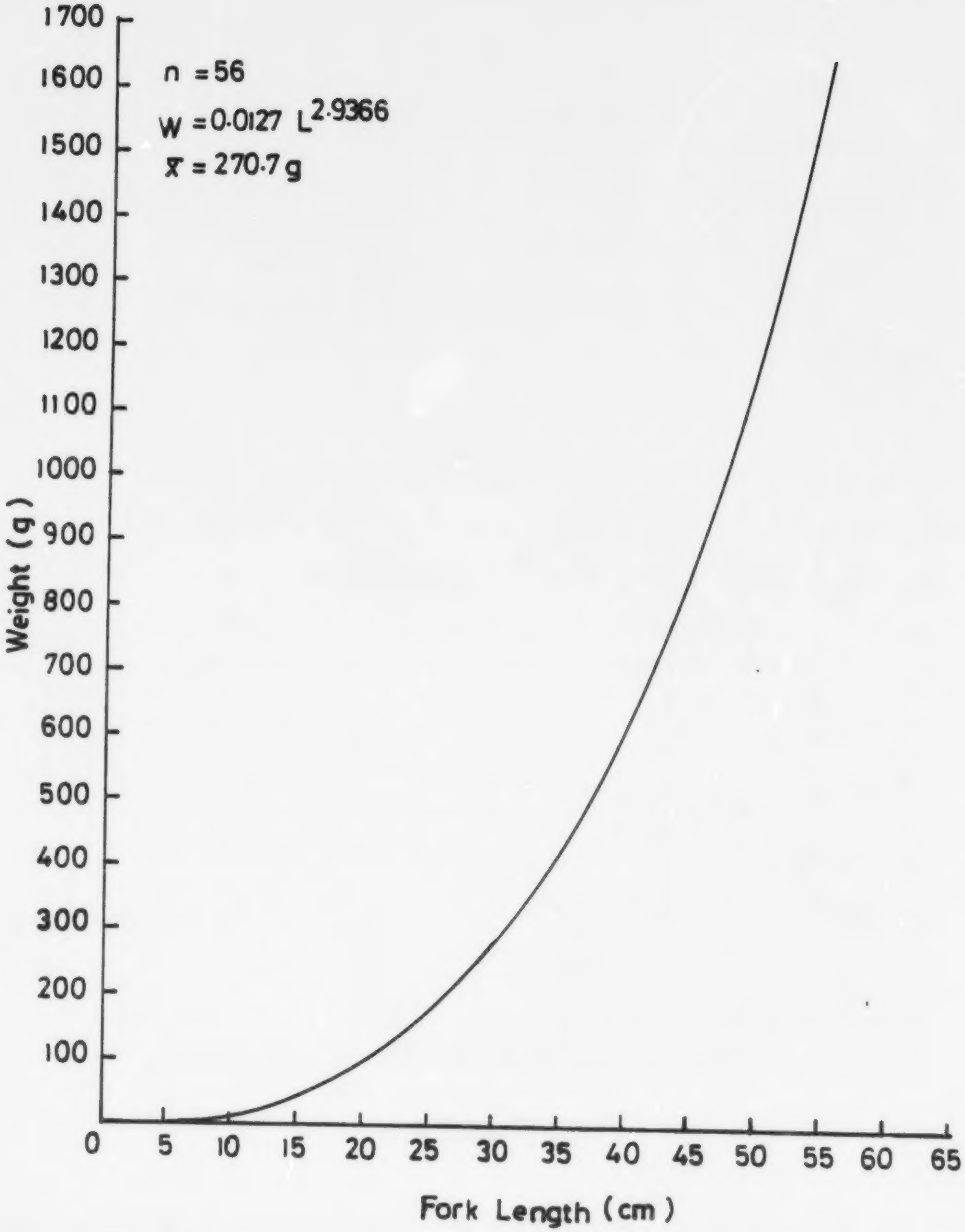


Fig. 22. Length-weight relationship of cisco caught in gillnets in the South Saskatchewan River in 1988. (n=number of fish; $\bar{x}$=mean weight)

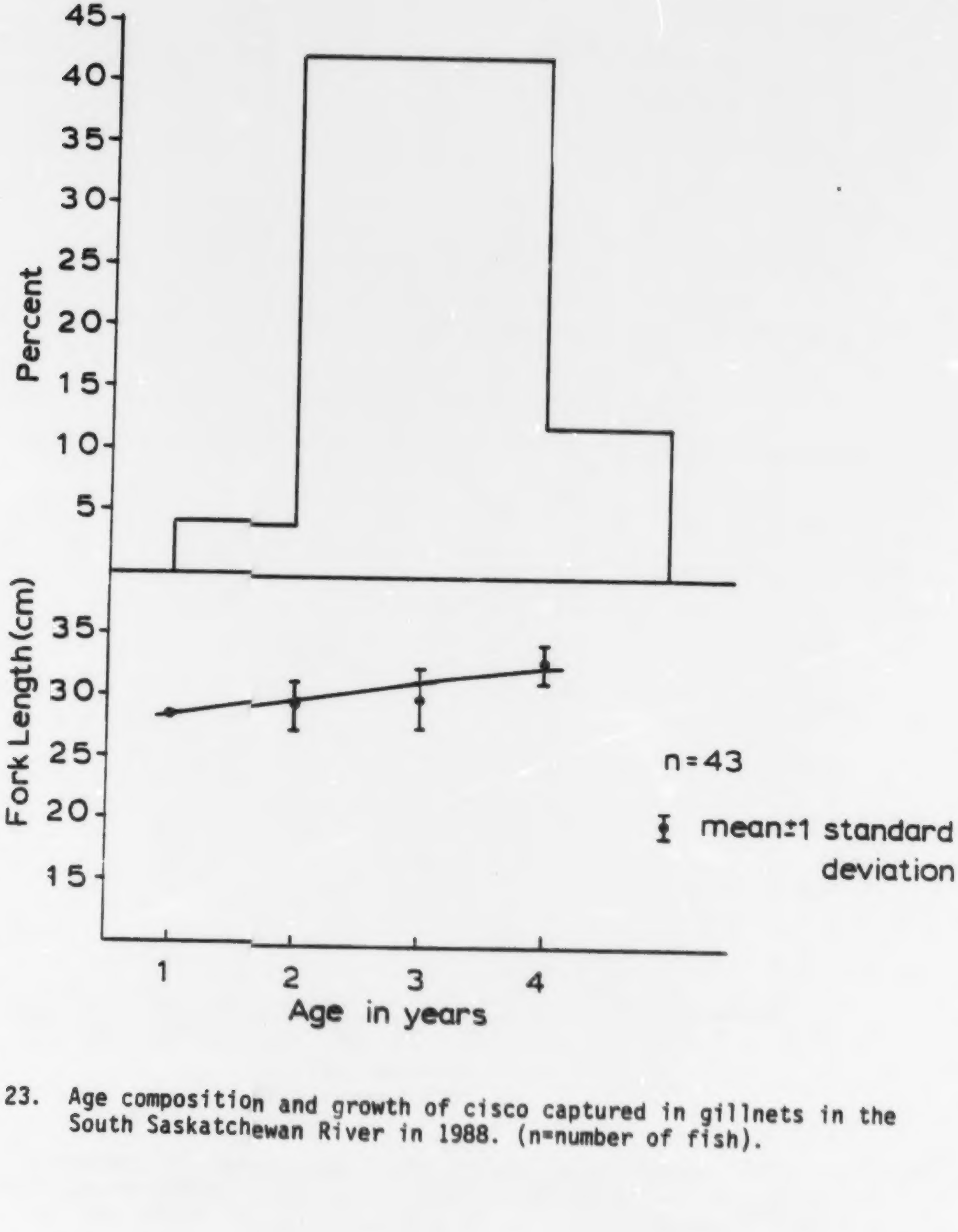


Fig. 23. Age composition and growth of cisco captured in gillnets in the South Saskatchewan River in 1988. (n=number of fish).

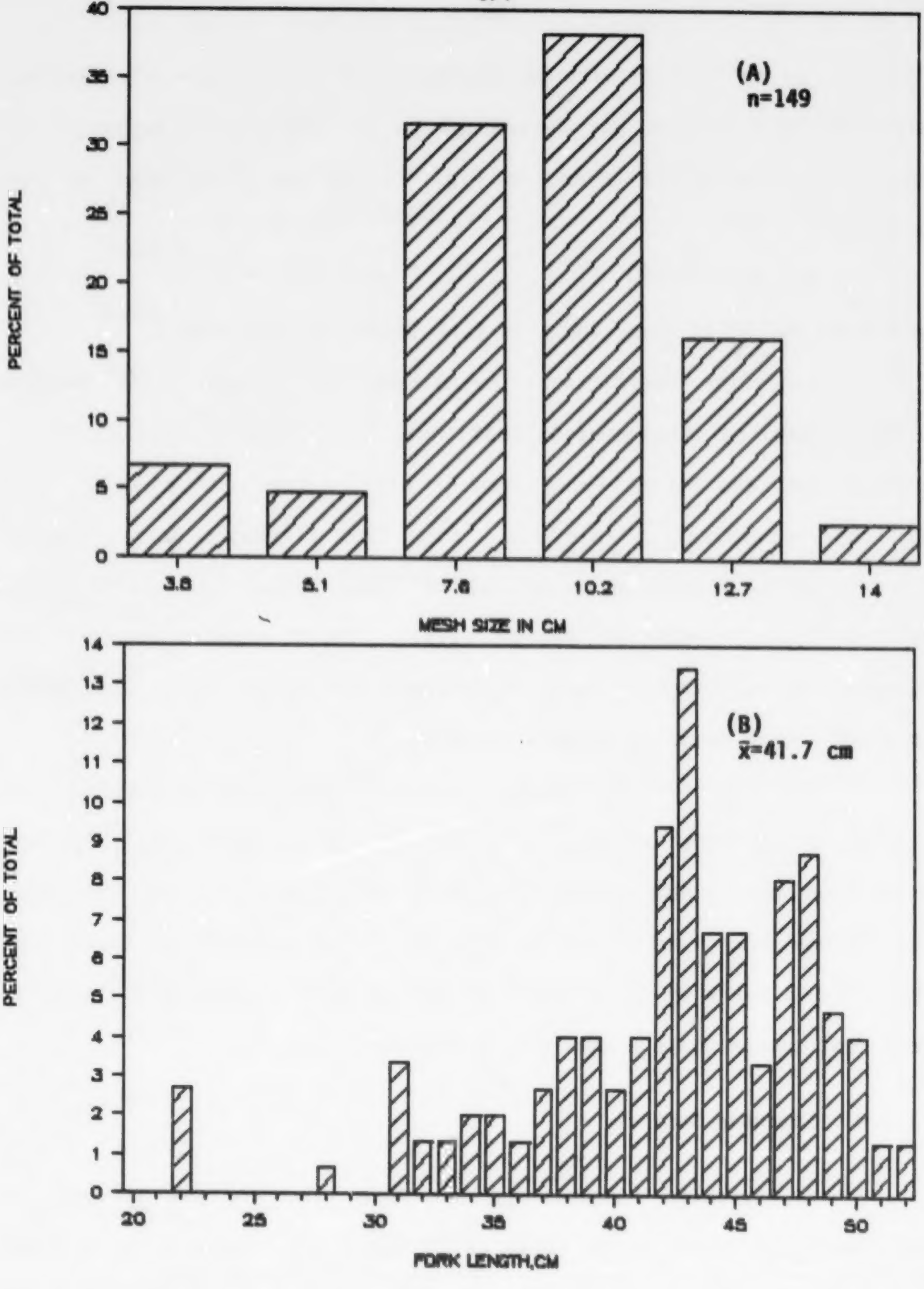


Fig. 24. Distribution of catch in various mesh sizes (A) and length-frequency distribution (B) of common white suckers caught in gillnets in the South Saskatchewan River in 1988. (n=total number caught; $\bar{x}$=mean fork length).

from 21.1 cm to 51.3 cm with an average of 41.7 cm (Table 8). Average weight of this species was determined to be 1196.2 g. The weight to length relationship is shown in Fig. 25 and is illustrated by the equation:

$$W=0.0039L^{3.1290}$$

where W is weight in grams and L is fork length in centimeters.

Condition coefficients calculated for common white suckers at the 5 sampling sites suggest that those fish caught at Estuary Ferry, Gardiner Dam, and Fenton Ferry were in similar condition at 1.53, 1.54 and 1.53 respectively (Table 10). Fish from Clarkboro Ferry were in slightly better condition (1.60) while those caught at Yorath Island had the lowest condition factor (1.49). Rich organic material at Clarkboro Ferry provides ideal conditions for growth of sludge worms and midge larvae normally eaten by suckers.

The leading fin ray of a pelvic fin was collected from the majority of suckers captured in 1988 for ageing purposes. The age composition and growth curve for common white suckers from the South Saskatchewan River are shown in Fig. 26. The majority of these fish were 6 and 8 years of age. Few fish younger than 4 years were captured. The oldest common white sucker was 13 years of age.

#### 4.1.2.9 Longnose Sucker

Eighty-seven longnose suckers were taken in the gillnets in 1988, making up 12.9% of the total catch (Table 7). Gardiner Dam yielded the highest catch (37%) of this species followed by Clarkboro Ferry (32%). Twenty (23%) longnose suckers were captured at Estuary Ferry and only 7 (8%) were caught at Fenton Ferry. None were taken at Yorath Island.

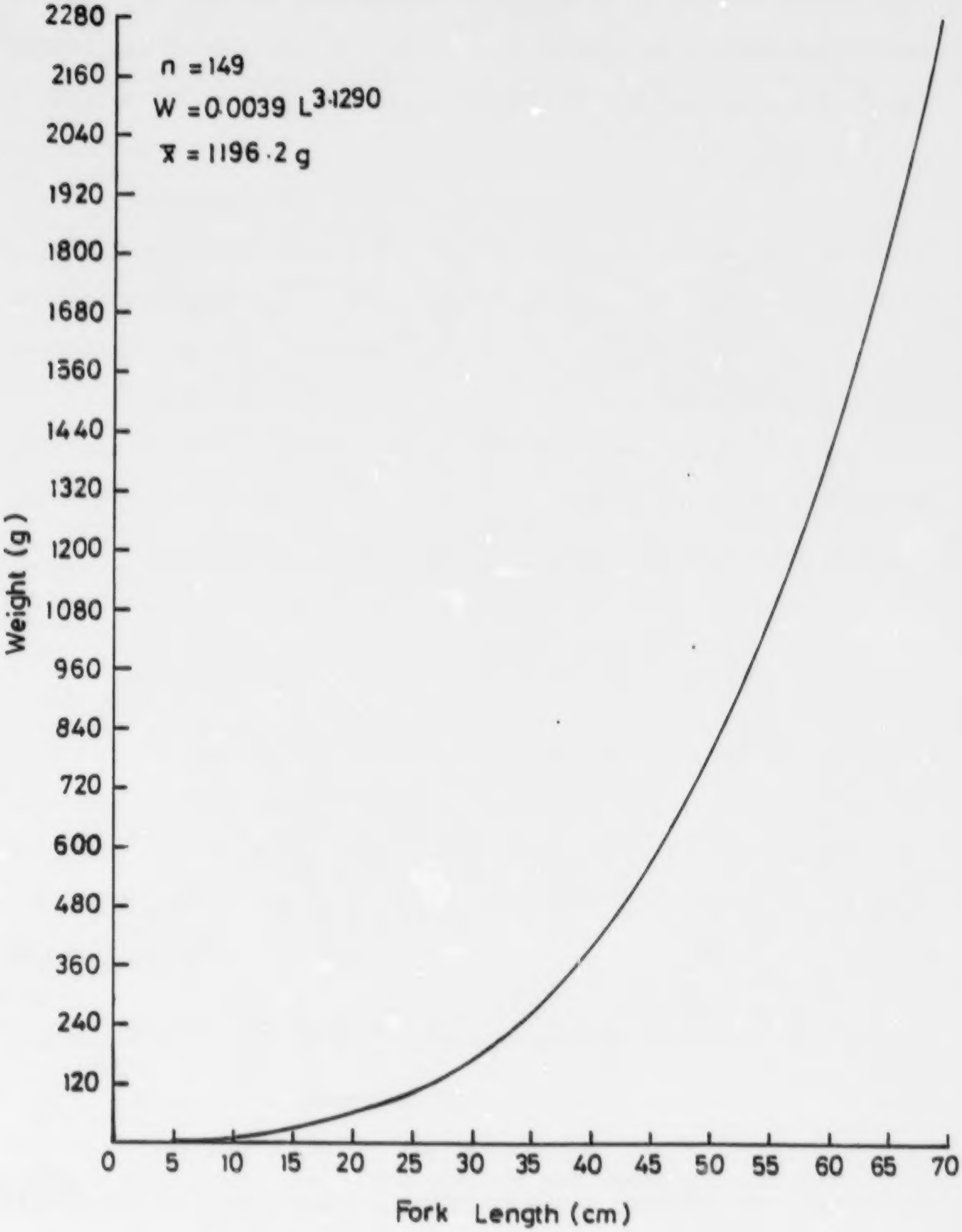


Fig. 25. Length-weight relationship of common white suckers caught in gillnets in the South Saskatchewan River in 1988. (n=number of fish; $\bar{x}$=mean weight)

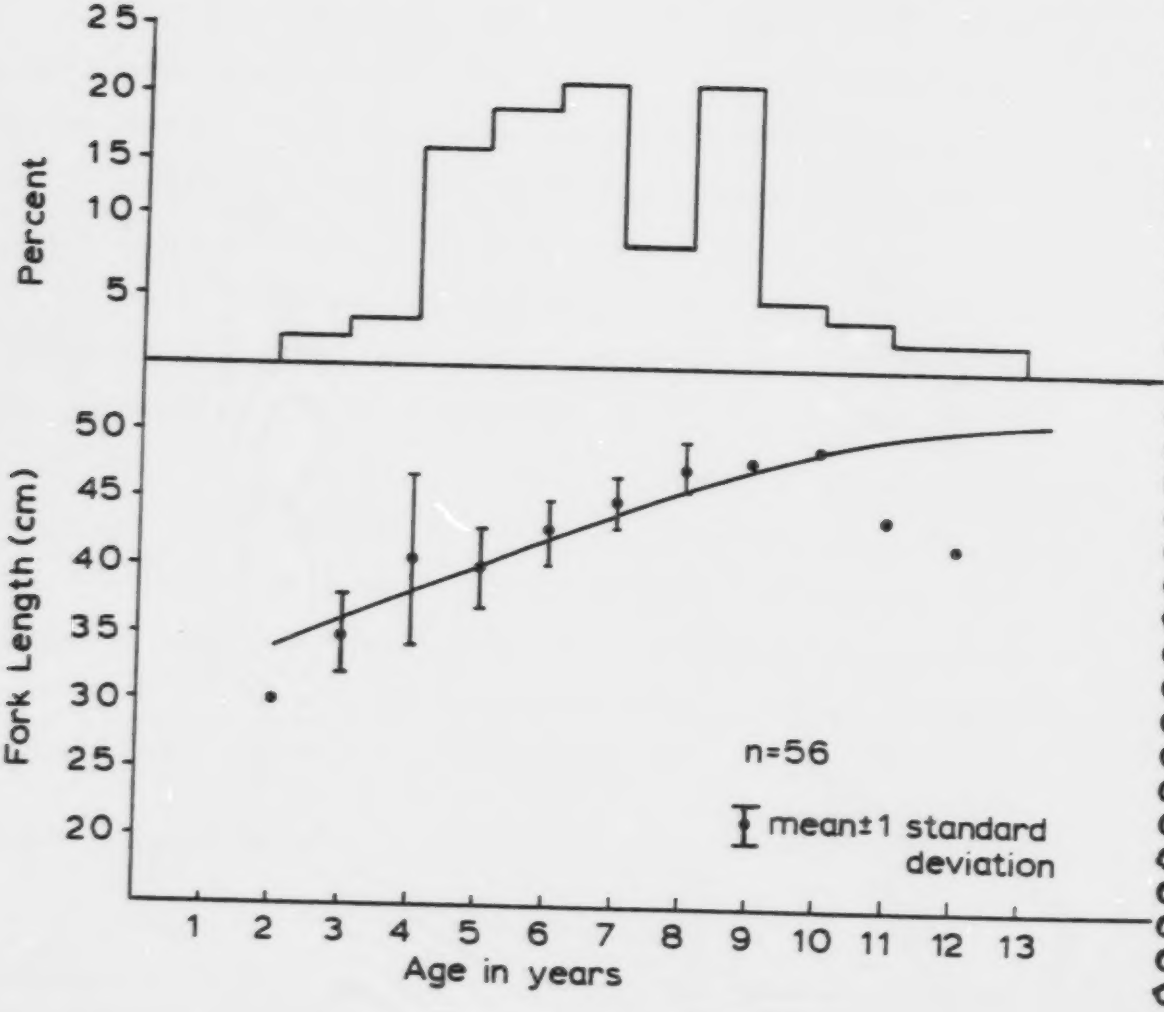


Fig. 26. Age compositon and growth of common white suckers captured in gillnets in the South Saskatchewan River in 1988. (n=number of fish).

The majority of this species were captured in the 7.6 cm mesh gillnet (Fig. 27) and were between 40 cm and 45 cm in fork length (Fig. 27). Sizes ranged from 16.4 cm to 50.6 cm with an average fork length of 42.1 cm (Table 9). The average weight of this species was 1052.2 g. The equation:

$$W=0.0038L^{3.3271}$$

where W is weight in grams and L is fork length in centimeters, describes the length-weight relationship of this species. The length-weight curve is shown in Fig. 28.

Coefficients of condition for longnose suckers show that fish at Fenton Ferry had a lower condition than those caught at the other sampling locations (Table 10). Condition factors of fish at Clarkboro Ferry and Estuary Ferry were similar. Longnose suckers from Gardiner Dam had the highest condition factor (1.37). Longnose suckers prefer clear, cold northern waters and may grow better below Gardiner Dam for this reason.

Age composition and growth of longnose suckers, based on fin ray age, is depicted in Fig. 29. Most fish were 5 years of age and the oldest was 10 years. Only 1 fish younger than 4 years was captured. The growth curve suggested a fairly rapid rate of growth in this species between 2 and 4 years of age.

### 4.1.2.10 Shorthead Redhorse

Seventy-nine shorthead redhorse were captured in gillnets in 1988, comprising 11.8% of the total catch (Table 7). This species was caught at all 5 sampling sites but the majority were taken from Gardiner Dam (40%) and Clarkboro Ferry (28%).

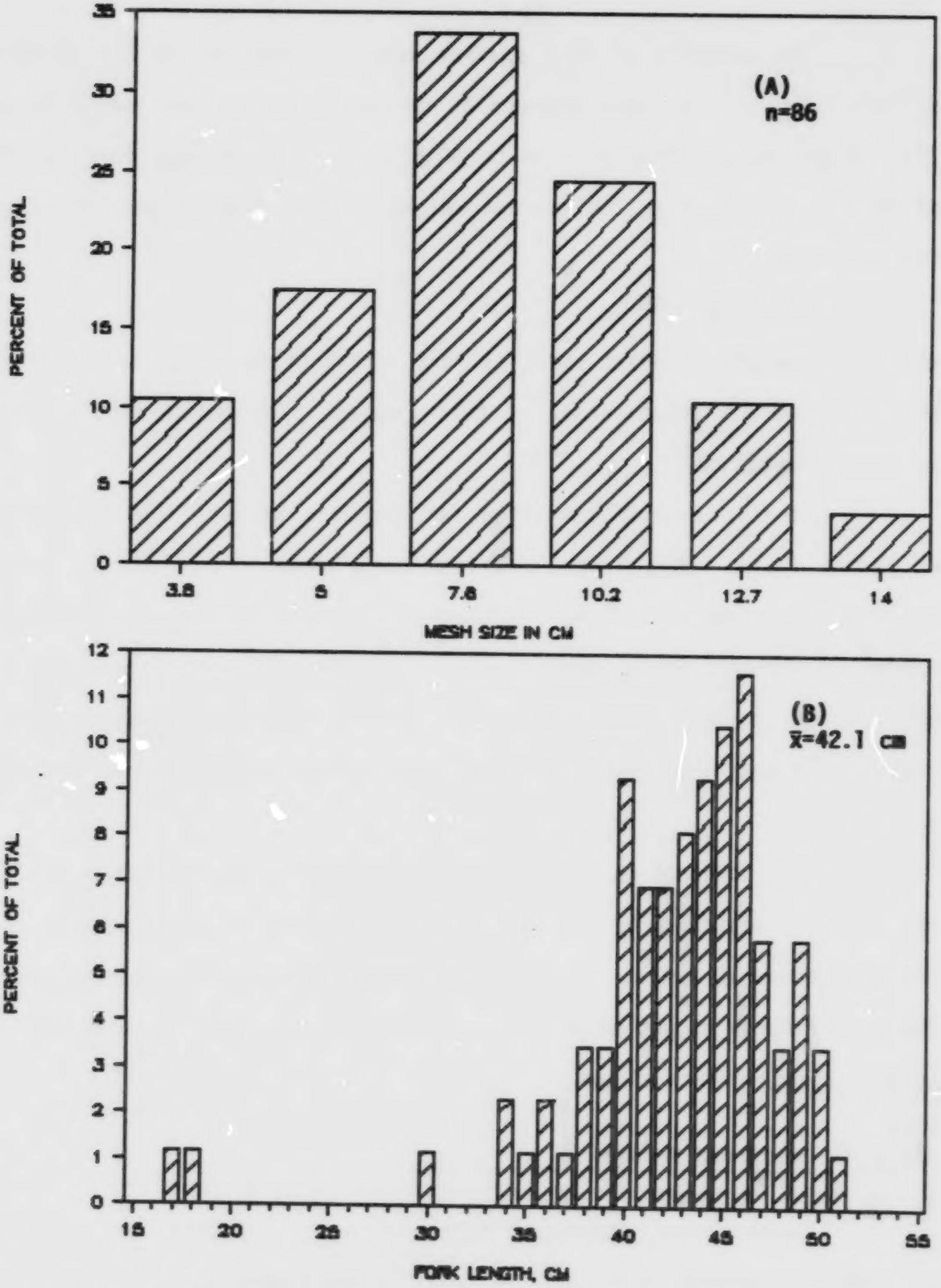


Fig. 27. Distribution of catch in various mesh sizes (A) and length frequency distribution (B) of longnose suckers caught in gillnets in the South Saskatchewan River in 1988. (n=total number caught; $\bar{x}$=mean fork length).

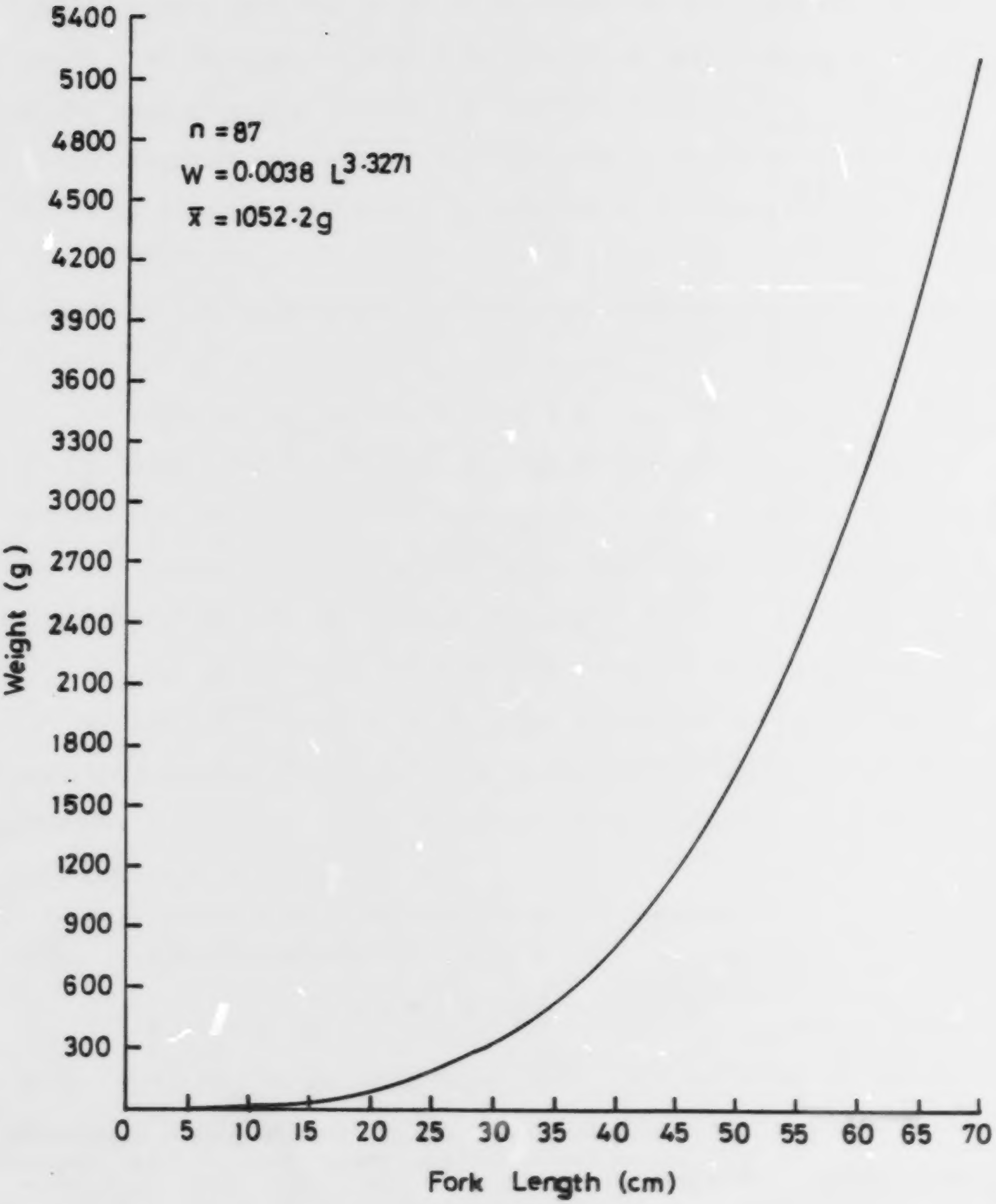


Fig. 28. Length-weight relationships of longnose suckers caught in gillnets in the South Saskatchewan River in 1988. (n=number of fish; $\bar{x}$=mean weight)

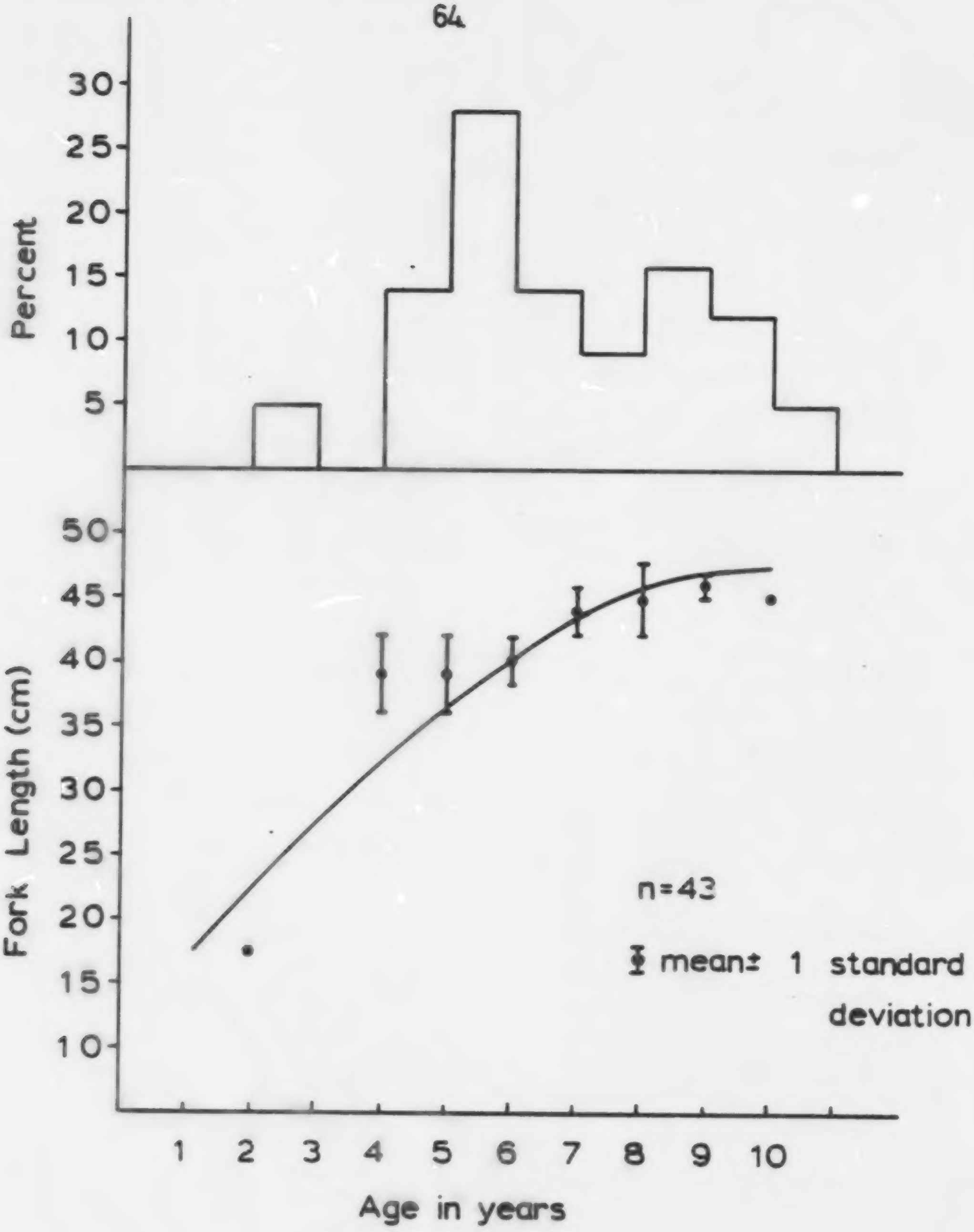


Fig. 29. Age composition and growth of longnose suckers captured in gillnets in the South Saskatchewan River in 1988. (n=number of fish).

Shorthead redhorse ranged in size from 17.2 cm to 56.8 cm in fork length and had an average length of 40.2 cm (Table 9). The length-frequency distribution (Fig. 30) shows that most fish were within the 40 - 45 cm range. The 10.2 cm and 7.6 cm mesh sizes appeared to be the most effective in catching shorthead redhorse (Fig. 30). The average weight of this species was determined to be 1131.5 g (Table 9). The weight to length relationship is described by the equation:

$$W=0.0130L^{3.2123}$$

where W is weight in grams and L is fork length in centimeters, and is shown in Fig. 31.

Calculated condition factors are shown in Table 10. Fish at the Estuary Ferry site had the lowest condition factor (K=1.53). Gardiner Dam and Fenton Ferry fish were in similar condition (K=1.62) and 1.63 respectively) but were slightly lower than those captured at Yorath Island (K=1.70) and Clarkboro Ferry (K=1.68).

Age composition and growth of shorthead redhorse, based on fin ray age, is shown in Fig. 32. The majority of these fish were 8 years of age. One fish younger than 4 years was captured and the oldest fish was 12 years of age. The growth curve suggests slow growth in this species after 6 years of age.

### 4.1.3 **Fish Tissue Analyses**

Results of metal scans carried out on flesh of walleye caught at the five sites in the South Saskatchewan River are shown in Table 12. Generally, levels of cadmium, chromium, nickel, copper, lead and arsenic were at or below the detection limit of the analytical method used. Measureable amounts of zinc, mercury and selenium were reported. Levels

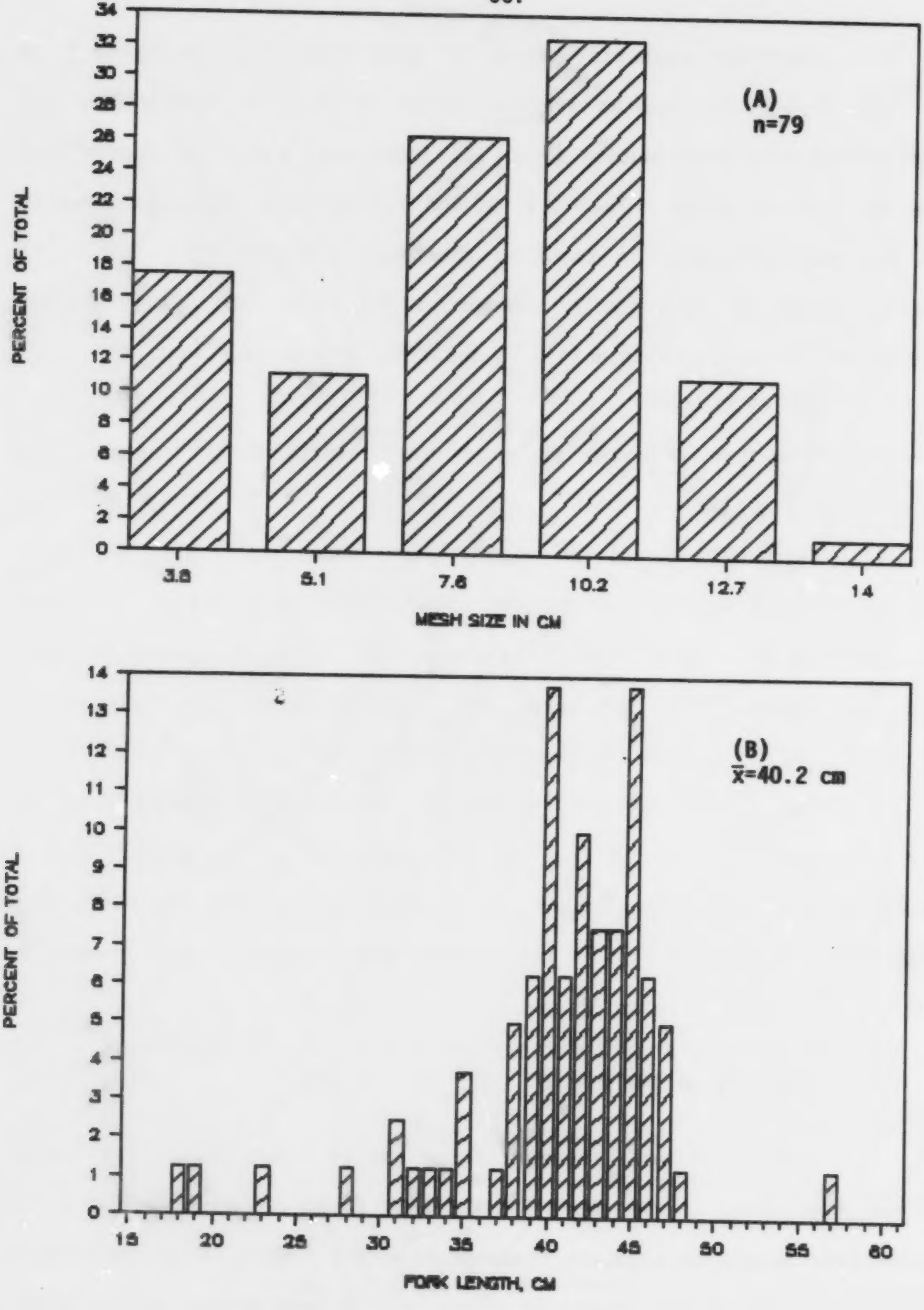


Fig. 30. Distribution of catch in various mesh sizes (A) and length-frequency distribution (B) of shorthead redhorse caught in gillnets in the South Saskatchewan River in 1988. (n=total number caught; $\bar{x}$=mean fork length).

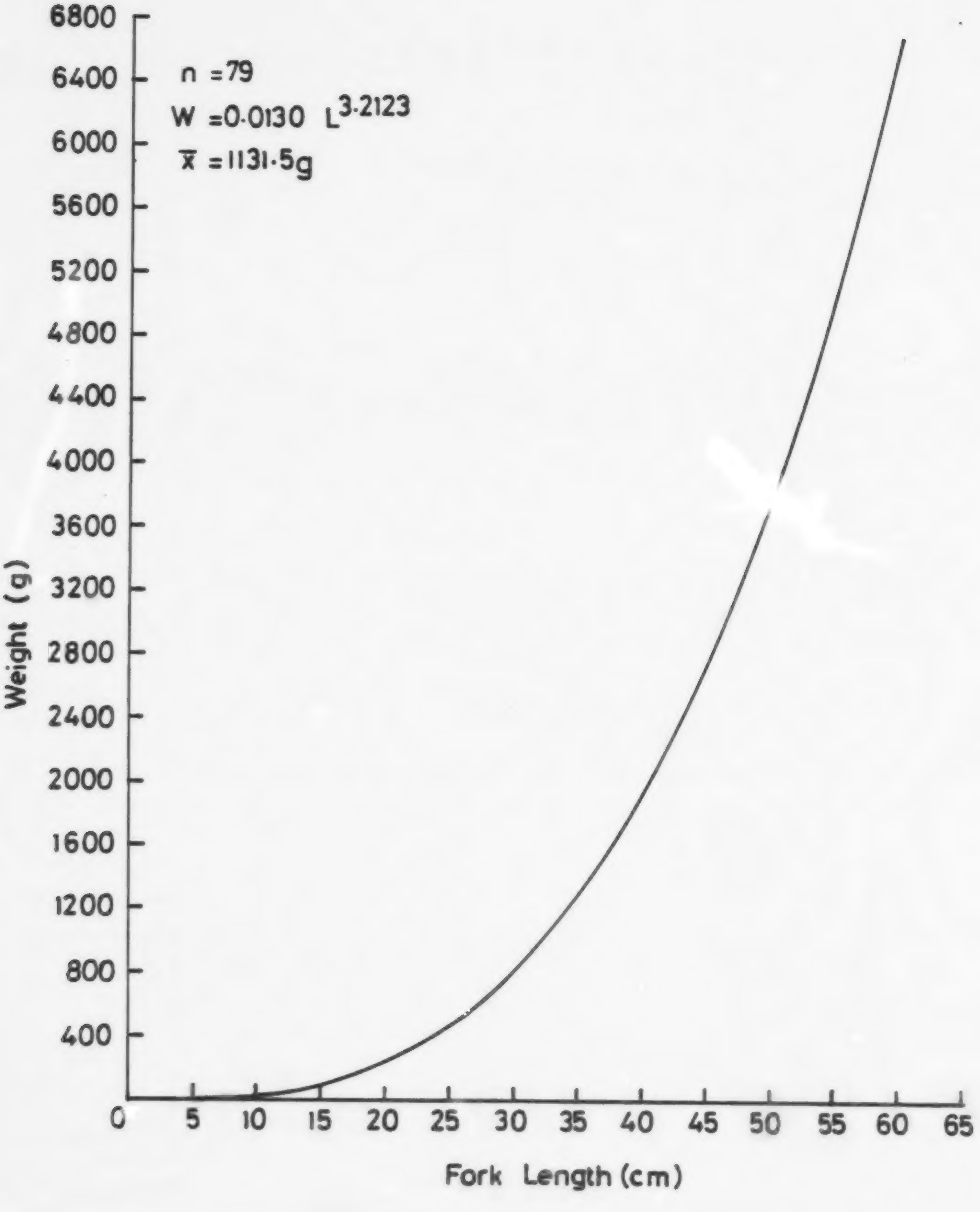


Fig. 31. Length-weight relationships of shorthead redhorse caught in gillnets in the South Saskatchewan River in 1988. (n=number of fish; $\bar{x}$=mean weight)

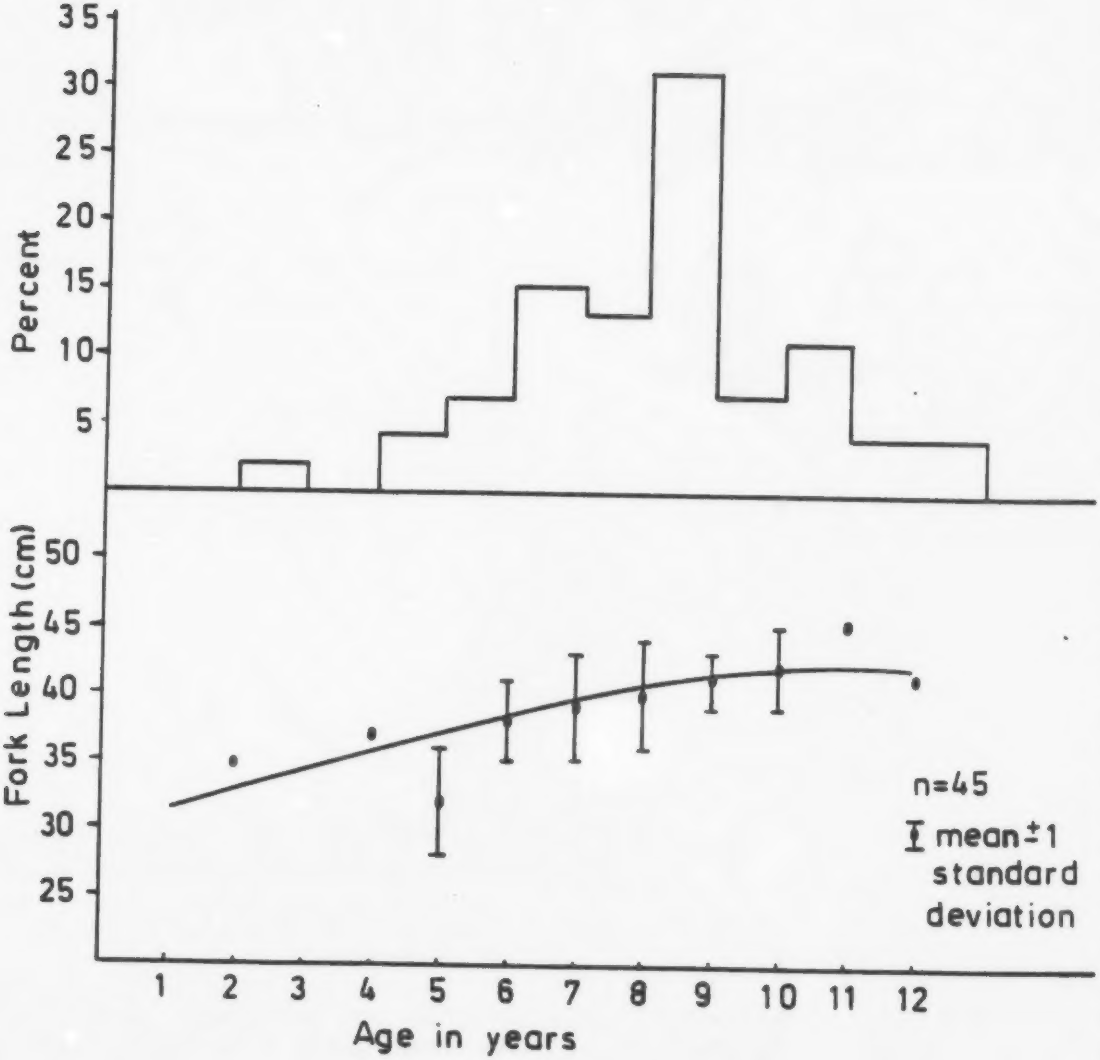


Fig. 32. Age composition and growth of shorthead redhorse captured in gillnets in the South Saskatchewan River in 1988. (n=number of fish).

Table 12: Results[1] of metal analyses ($mg.kg^{-1}$) of flesh from walleye in the South Saskatchewan River, 1988.

| Sampling Site | Length (cm) | Wt/g. | Cd | Cr | Ni | Cu | Pb | Zn | Hg | As | Se |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Estuary Ferry | 28.4 | 225 | 0.05 | <0.20 | 0.08 | <0.20 | <0.10 | 4.17 | 0.45 | <0.05 | 0.78 |
| Estuary Ferry | 28.0 | 220 | 0.10 | <0.20 | 0.10 | <0.20 | <0.10 | 4.51 | 0.48 | <0.05 | 0.68 |
| Estuary Ferry | 68.2 | 3 300 | <0.02 | <0.20 | 0.05 | <0.20 | <0.10 | 3.50 | 1.02 | <0.05 | 0.73 |
| Gardiner Dam | 60.0 | 2 450 | <0.02 | <0.20 | <0.05 | <0.20 | <0.10 | 5.44 | 0.81 | 0.06 | 0.65 |
| Gardiner Dam | 49.9 | 1 300 | <0.02 | <0.20 | <0.05 | <0.20 | <0.10 | 6.50 | 0.46 | 0.06 | 0.56 |
| Gardiner Dam | 37.5 | 575 | <0.02 | <0.20 | <0.05 | <0.20 | <0.10 | 4.05 | 0.41 | <0.05 | 0.88 |
| Yorath Island | 45.0 | 850 | <0.02 | <0.20 | <0.05 | <0.20 | <0.10 | 3.54 | 0.30 | <0.05 | 0.58 |
| Yorath Island | 43.1 | 925 | <0.02 | <0.20 | <0.05 | 0.21 | <0.10 | 5.77 | 0.30 | <0.05 | 0.56 |
| Yorath Island | 45.4 | 1 175 | <0.02 | <0.20 | <0.05 | <0.20 | <0.10 | 5.98 | 0.27 | <0.05 | 0.62 |
| Clarkboro Ferry | 50.0 | 1 550 | <0.02 | <0.20 | <0.05 | <0.20 | <0.10 | 4.64 | 0.71 | <0.05 | 0.69 |
| Clarkboro Ferry | 43.7 | 850 | <0.02 | <0.20 | <0.05 | <0.20 | <0.10 | 4.41 | 1.01 | <0.05 | <0.66 |
| Clarkboro Ferry | 60.0 | 2 150 | <0.02 | <0.20 | <0.05 | 0.29 | <0.10 | 8.40 | 1.41 | 0.05 | 0.74 |
| Fenton Ferry | 65.7 | 2 950 | <0.02 | <0.20 | <0.05 | <0.20 | <0.10 | 6.14 | 0.50 | <0.05 | 0.74 |
| Fenton Ferry | 35.5 | 450 | <0.02 | <0.20 | <0.05 | <0.20 | <0.10 | 4.67 | 0.60 | <0.05 | 0.75 |
| Fenton Ferry | 42.2 | 800 | <0.02 | <0.20 | <0.05 | <0.20 | <0.10 | 4.88 | 0.84 | <0.05 | 0.84 |

1 - Analysed by Environment Canada

of zinc ranged from 3.50 to 8.40 mg·kg$^{-1}$. The highest value was reported in a fish taken at Clarkboro Ferry. No clear trend in levels between sampling sites is evident. Similarly, selenium levels ranged from 0.56 mg·kg$^{-1}$ to 0.88 mg·kg$^{-1}$ with no trend between sampling sites. Mercury levels ranged from 0.27 mg·kg$^{-1}$ to 1.41 mg·kg$^{-1}$. The lowest average levels reported by Environment Canada were found at Yorath Island upstream of Saskatoon ($\bar{x}$=0.29 mg·kg$^{-1}$). Highest levels were found at Clarkboro Ferry ($\bar{x}$=1.04 mg·kg$^{-1}$). Other means ranged from 0.56 mg·kg$^{-1}$ to 0.65 mg·kg$^{-1}$. The larger fish generally had higher levels of mercury in their flesh.

Results of mercury analyses of walleye and other species undertaken by the Provincial Laboratory are summarized in Table 13. Average levels of mercury at the three sites upstream of Saskatoon are identical to those reported by Environment Canada. Higher levels were reported from Clarkboro and Fenton Ferry. The latter ($\bar{x}$=1.26 mg·kg$^{-1}$) was significantly affected by 1 fish whose mercury level was 2.74 mg·kg$^{-1}$. Sauger produced results similar to walleye. Goldeye were consistently marginally lower. Northern pike consistently contained much less mercury than the other species sampled. The trend between sampling stations was similar for all species with lowest levels reported just upstream of Saskatoon and highest levels downstream.

### 4.1.4 Fish Spawning Habitat

The substrate of the South Saskatchewan River channel is predominantly sand with numerous areas of cobble and gravel or boulder. Midstream flow as measured by Beak Associates ranged from 53.0 m$^{3}$sec$^{-1}$ to 153.0 m$^{3}$.sec$^{-1}$ at Estuary Ferry. All other sites showed a constant

Table 13: Summary results of mercury analyses (mg. kg $^{-1}$) of flesh from four species of fish taken from the South Saskatchewan River System, 1988.

| Location | Sample | Mercury level (mg/kg) Range | Mercury level (mg/kg) Average |
|---|---|---|---|
| Estuary Ferry | 6 Sauger | 0.32 - 0.95 | 0.52 |
| | 10 Walleye | 0.35 - 1.35 | 0.65 |
| | 1 Northern pike | 0.34 | 0.34 |
| | 10 Goldeye | 0.29 - 0.68 | 0.40 |
| Gardiner Dam (Downstream) | 10 Walleye | 0.41 - 0.89 | 0.57 |
| | 2 Northern pike | 0.35 - 0.42 | 0.38 |
| | 1 Goldeye | 0.47 | 0.47 |
| Yorath Island | 6 Walleye | 0.12 - 0.34 | 0.27 |
| | 7 Northern pike | 0.13 - 0.35 | 0.18 |
| Clarkboro Ferry | 2 Sauger | 0.89 - 1.85 | 1.39 |
| | 8 Walleye | 0.72 - 2.00 | 1.21 |
| | 2 Northern pike | 0.37 - 1.37 | 0.87 |
| | 1 Goldeye | 1.18 | 1.18 |
| Fenton Ferry | 1 Sauger | 1.88 | 1.88 |
| | 9 Walleye | 0.48 - 2.74 | 1.26 |
| | 11 Northern pike | 0.34 - 1.03 | 0.47 |
| | 5 Goldeye | 0.96 - 1.90 | 1.25 |
| Swift Current Creek | 4 Walleye | 0.46 - 1.08 | 0.76 |
| | 9 Northern pike | 0.20 - 0.66 | 0.45 |
| Broderick Reservoir | 7 Northern pike | 0.18 - 0.37 | 0.30 |
| Dellwood Reservoir | 10 Walleye | 0.07 - 0.11 | 0.10 |

velocity of 45.0 $m^3.sec^{-1}$ throughout the summer (Appendix 1). Quiet shallow water is common near the shore throughout the reach of the River . Pool areas below shallow rocky riffles were more prevalent in the lower reaches of the river (i.e. around Fenton Ferry) than they were in the upper reaches near Estuary Ferry. The shoreline was variable being formed by grassy or tree lined banks, mud cliffs, sand or mud flats, and rocky "beaches". In many areas, heavy siltation of the river bottom was apparent near shore.

Spawning of fish within the South Saskatchewan River or its tributaries was not observed in 1988. As a result of very low spring runoff no flowing tributary streams were found from the confluence of the Red Deer River to a point approximately 10 km downstream. Water levels in Swift Current Creek were very low making spawning areas of clean gravel and cobble inaccessible to many of the large fish found near the juncture with Lake Diefenbaker. Cabri Creek, Munroe Creek and Taggart Creek all flow into Lake Diefenbaker and were dry when checked on May 17, 1988. Several other small streams in the area were also dry. Three tributary streams located within approximately 8 km below Gardiner Dam were dry. No tributary streams larger than drainage ditches were found within 8 km of Yorath Island, 6 km of Clarkboro Ferry, or 10 km of Fenton Ferry. Therefore, spawning, particularly in dry years appears to be restricted to the river itself.

An abundance of swift water combined with coarse sand, gravel, and/or cobble are present and offer suitable spawning habitat for species such as suckers, walleye and sauger (See Figs. 33-37). Flooded grassy areas along the shoreline are preferred spawning habitat for northern pike (Scott and Crossman, 1973). These are virtually nonexistant in

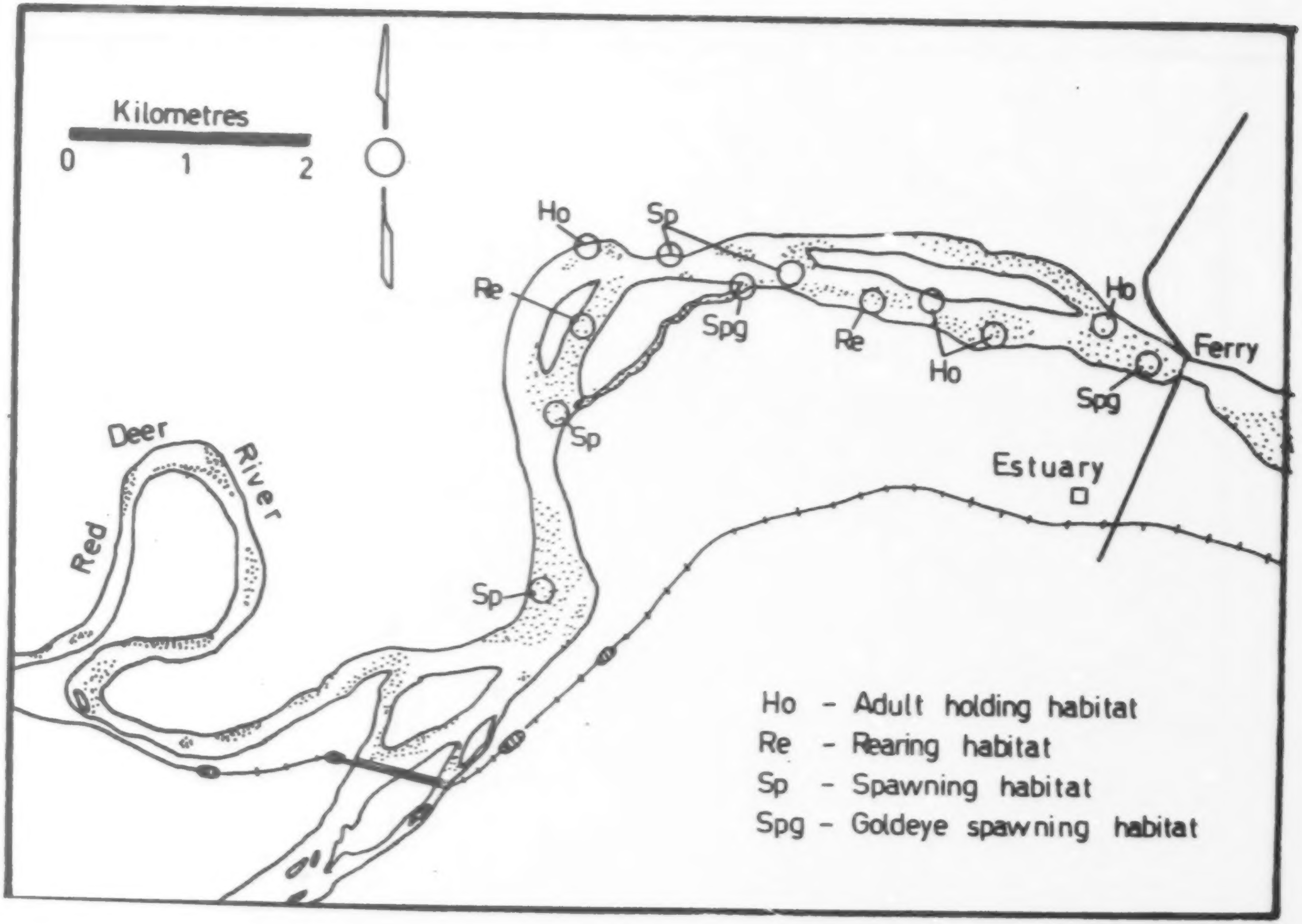


Fig. 33 Potential areas of critical fish habitat in the South Saskatchewan River around Estuary Ferry.

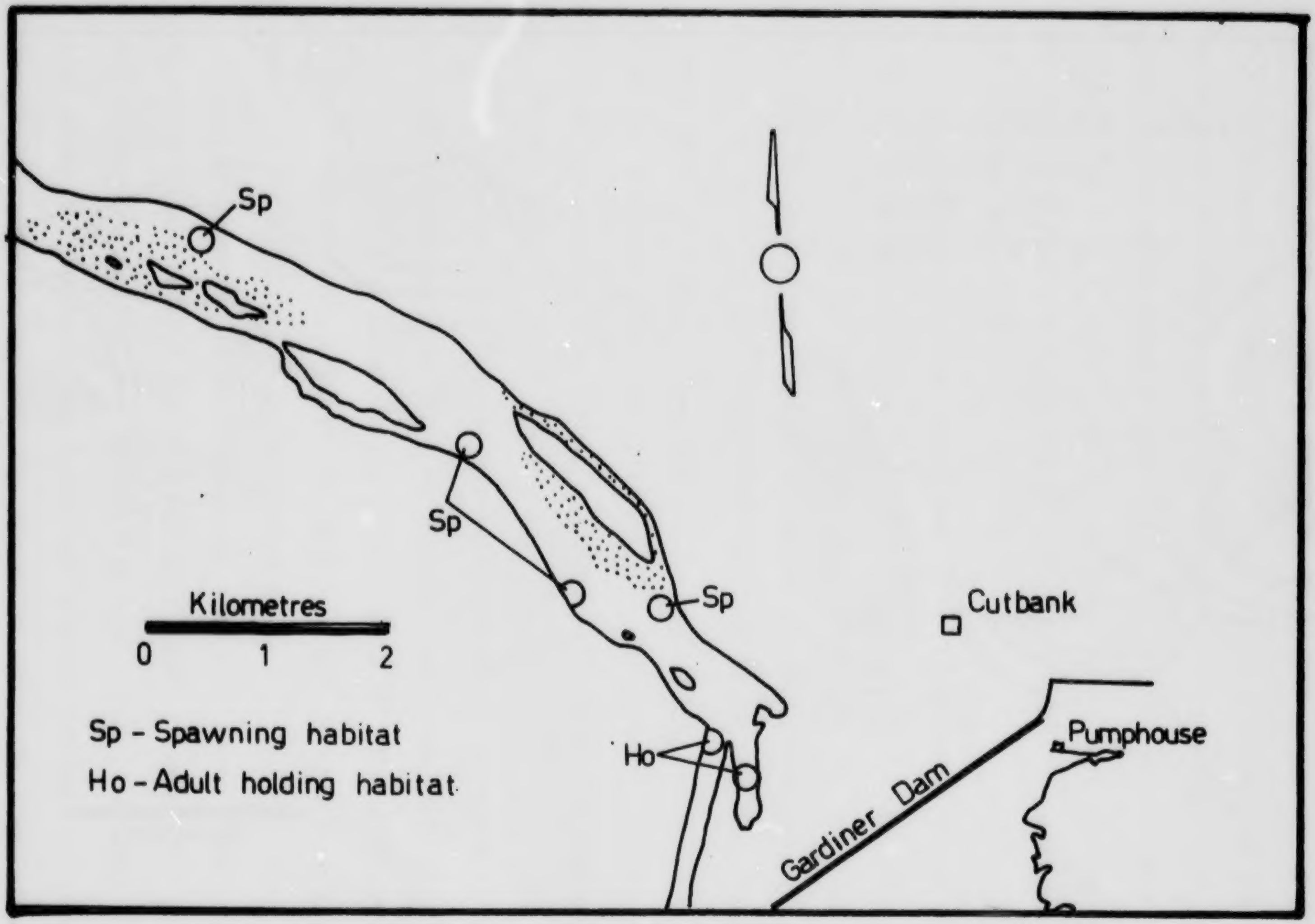


Fig. 34 Potential areas of critical fish habitat in the South Saskatchewan River below Gardiner Dam.

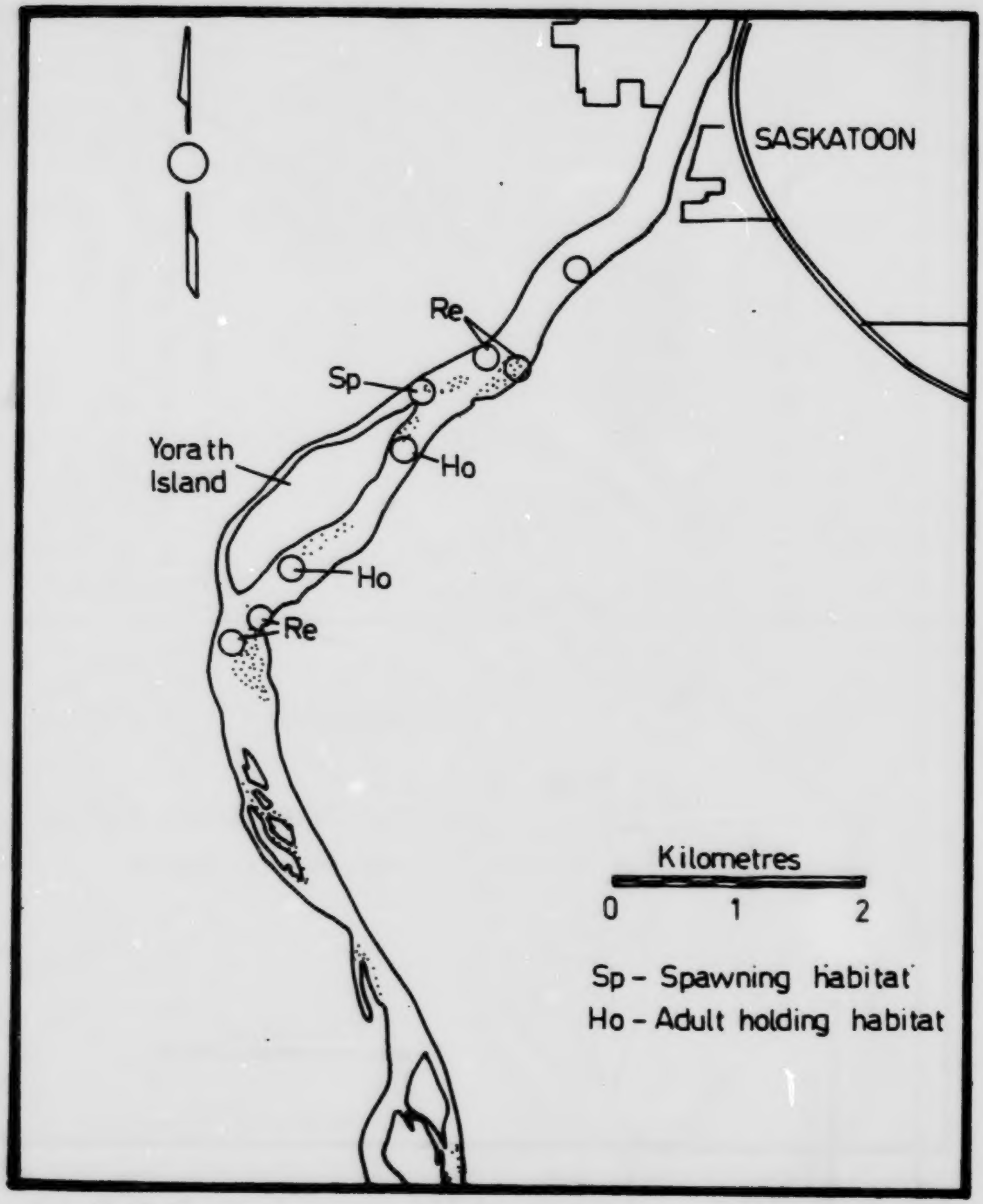


Fig. 35 Potential areas of critical fish habitat in the South Saskatchewan River around Yorath Island.

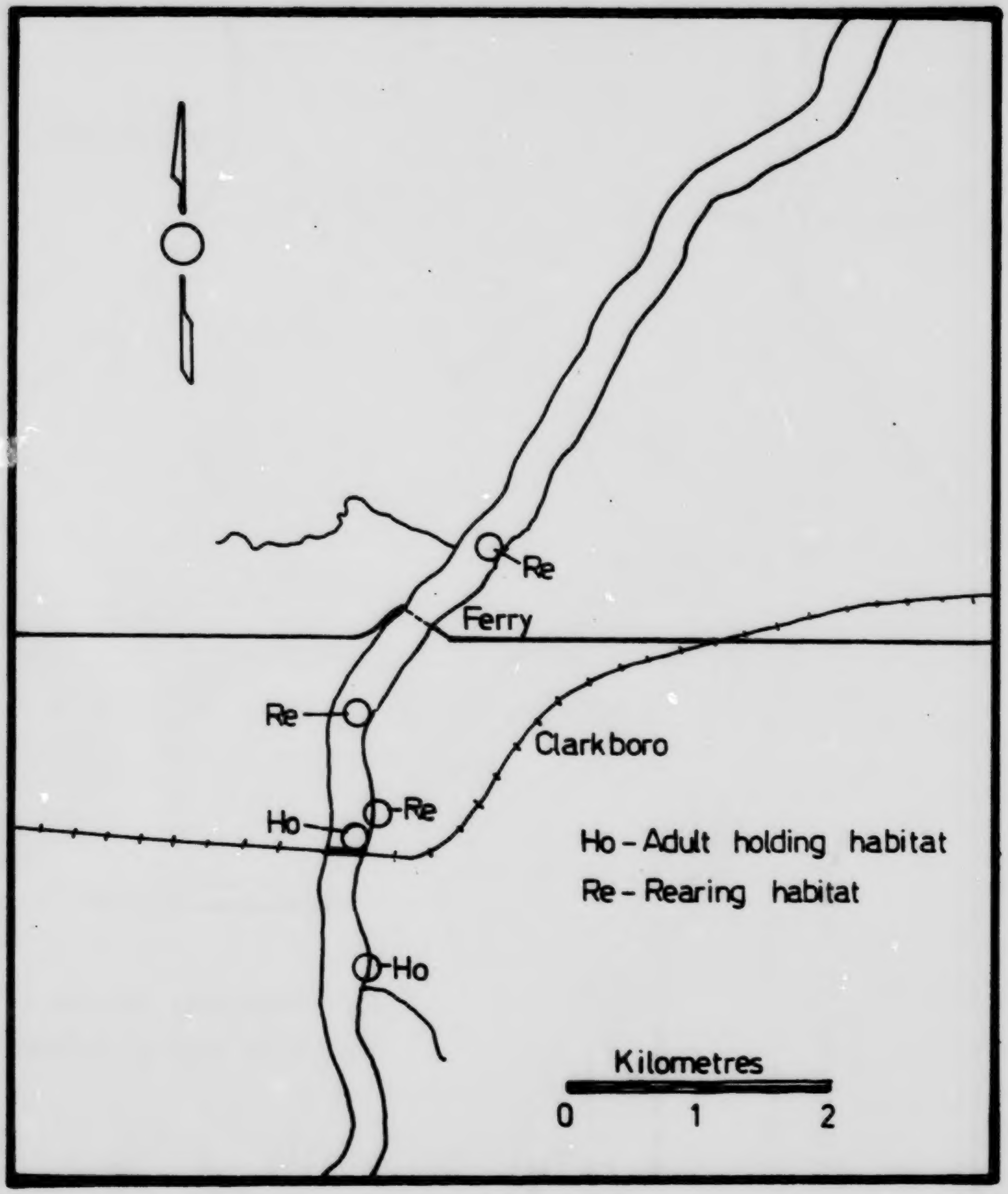


Fig. 36 Potential areas of critical fish habitat in the South Saskatchewan River around Clarkboro Ferry.

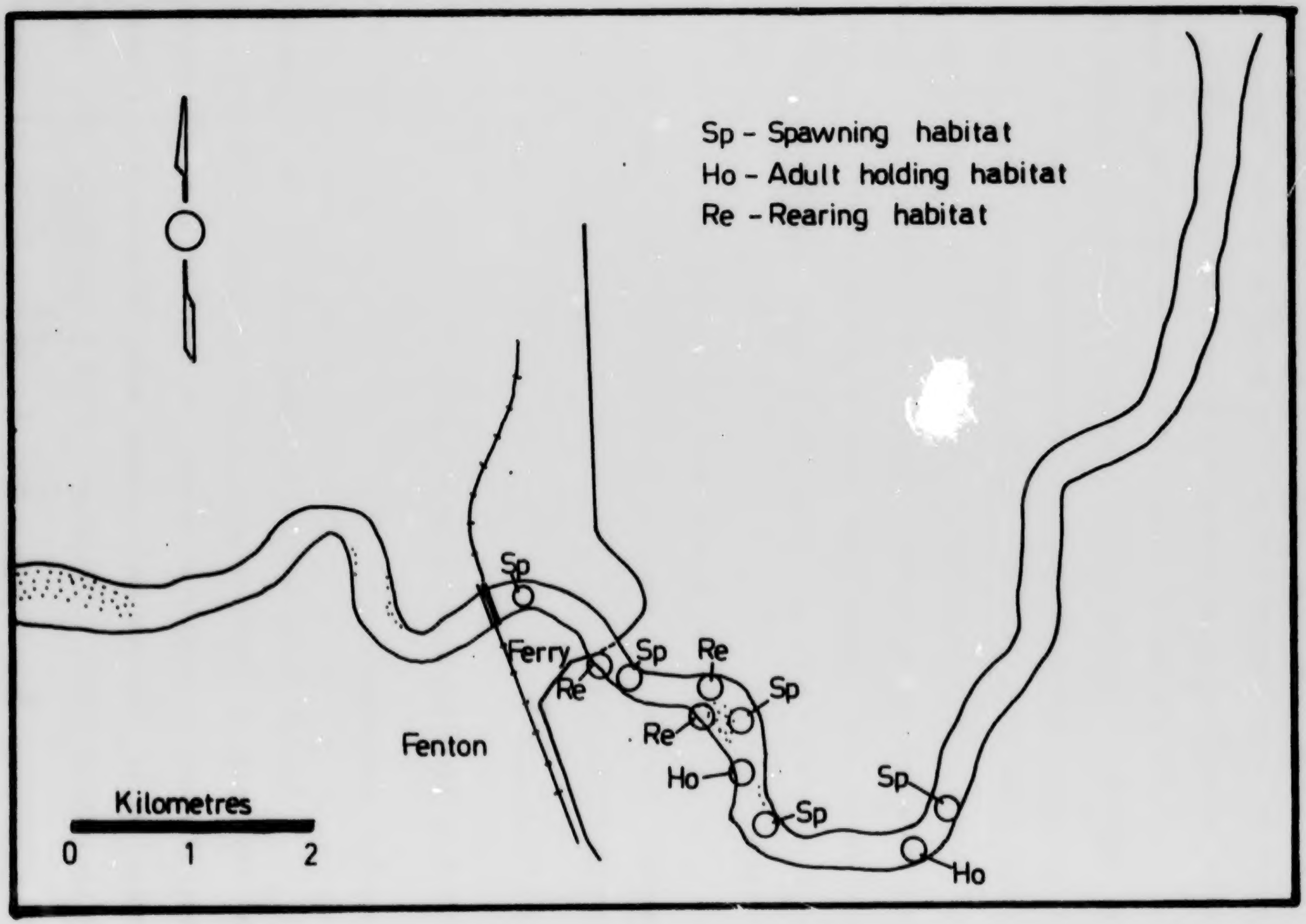


Fig. 37 Potential areas of critical fish habitat in the South Saskatchewan River around Fenton Ferry.

the South Saskatchewan. Similarly shallow backwater areas, typical of goldeye spawning habitat, has, in many cases been reduced to nothing more than large stagnant puddles. The exception is near Estuary Ferry where two potential goldeye spawning sites were identified (Fig. 33).

The presence of juvenile fish in the seine net was used as an indicator of rearing habitat. Walleye and northern pike were found at all sites, except Gardiner dam, and were generally found in the same areas (Figs. 33 & 35 - 37). At Estuary Ferry, such areas tended to be shallow with a predominantly rocky bottom. At Yorath Island, and Clarkboro and Fenton ferries, however, the substrate was a sand-mud combination that yielded some heavy growth of vegetation. Northern pike were more frequently encountered in these latter areas than were walleye.

No sauger or goldeye were found using the seine net. One mooneye juvenile was found at Estuary Ferry in a deep hole with sand/boulder bottom.

## 4.2 RESERVOIRS

### 4.2.1 Saskatoon Southeast Water Supply

#### 4.2.1.1 Invertebrates

Benthic fauna sampled by Ekman dredge in the 6 reservoirs of the Saskatoon Southeast Water Supply are shown in Table 14. The most frequently encountered groups, in order of abundance, included midge larvae (Chironomidae), sludge worms (Oligochaeta), fingernail clams (Sphaeriidae), freshwater shrimp (Amphipoda), and snails

Table 14: Numbers and total weight of invertebrate specimens sampled per Ekman dredge in the 6 reservoirs of the Saskatoon Southeast Water Supply System in 1988.

| | Broderick | Brightwater | Blackstrap | Bradwell | Zelma | Dellwood |
|---|---|---|---|---|---|---|
| Trichoptera | | | | | | |
| Hydropsychidae | 0.25 | - | - | - | - | - |
| Limnephilidae | 0.50 | - | - | - | - | - |
| Calamoceratidae | - | - | 0.20 | - | - | - |
| Diptera | | | | | | |
| Chironomidae | 24.25 | 7.75 | 16.80 | 32.25 | 22.5 | 111.2 |
| Ceratopogonidae | 1.25 | 2.25 | 5.60 | - | - | 0.60 |
| Coleoptera | | | | | | |
| Dytiscidae | - | - | - | - | 0.50 | - |
| Odonata | | | | | | |
| Coenagrionidae | 2.50 | - | - | - | - | - |
| Hemiptera | | | | | | |
| Corixidae | - | - | - | - | - | 0.20 |
| Hirudinea | 0.50 | - | 0.20 | - | - | - |
| Amphipoda | | | | | | |
| Gammaridae | 13.50 | - | 36.20 | - | 35.75 | 5.00 |
| Sphaeriidae | 21.00 | 16.75 | 29.80 | 8.50 | 0.25 | 55.8 |
| Gastropoda | 4.75 | 0.25 | 22.60 | 1.75 | - | 14.60 |
| Oligochaeta | 14.00 | - | 110.2 | - | 4.00 | 0.60 |
| Total no. | 82.5 | 27.0 | 221.6 | 42.50 | 63.0 | 188.0 |
| No. dredges | 4 | 4 | 5 | 4 | 4 | 5 |
| Wet weight, mg | 742.5 | 965.0 | 568.0 | 1302.5 | 1517.5 | 3884.0 |
| Dry weight, kg $ha^{-1}$ | 40.5 | 52.63 | 30.98 | 71.04 | 103.46 | 211.85 |

(Gastropoda). Midge larvae and fingernail clams were caught in all 6 locations but were most numerous in Dellwood Reservoir. Sludge worms were found in Brightwater, Blackstrap, Zelma, and Dellwood Reservoirs and were most abundant in Blackstrap Reservoir. Freshwater shrimp were present in the same 4 sites but were most numerous in Zelma Reservoir. Snails were collected at all locations except Zelma and were most frequently encountered in Blackstrap Reservoir.

The total number of benthic organisms captured was greatest in Blackstrap Reservoir (10 072.m$^{-2}$). Brightwater Reservoir yielded the smallest number of organisms (1227.m$^{-2}$). Standing biomass of organisms varied among sites ranging from 30.98 kg.ha$^{-1}$ in Blackstrap Reservoir to 211.85 kg.ha$^{-1}$ in Dellwood Reservoir (Table 14).

### 4.2.1.2 Fish Species

Eight species were collected by gillnetting and seining in the 6 reservoirs of the Saskatoon Southeast Water Supply. These included walleye, northern pike, yellow perch, common white sucker, shorthead redhorse, lake whitefish, fathead minnows and brook stickleback.

A total of 776 fish comprising 6 species was caught in the gillnets. Over 50% of this catch was obtained from Dellwood and Bradwell reservoirs (Fig. 38). Fishing effort was equal in all reservoirs except Blackstrap where one additional net was set (Table 15).

The most frequently encountered species were walleye, lake whitefish, and yellow perch (Table 16). Walleye were the most numerous, comprising 34% of the total catch, but only contributed 24.8% of the total catch weight. Lake whitefish ranked second in numbers (25.7%) but outweighed the walleye, comprising 46.3% of the total catch weight.

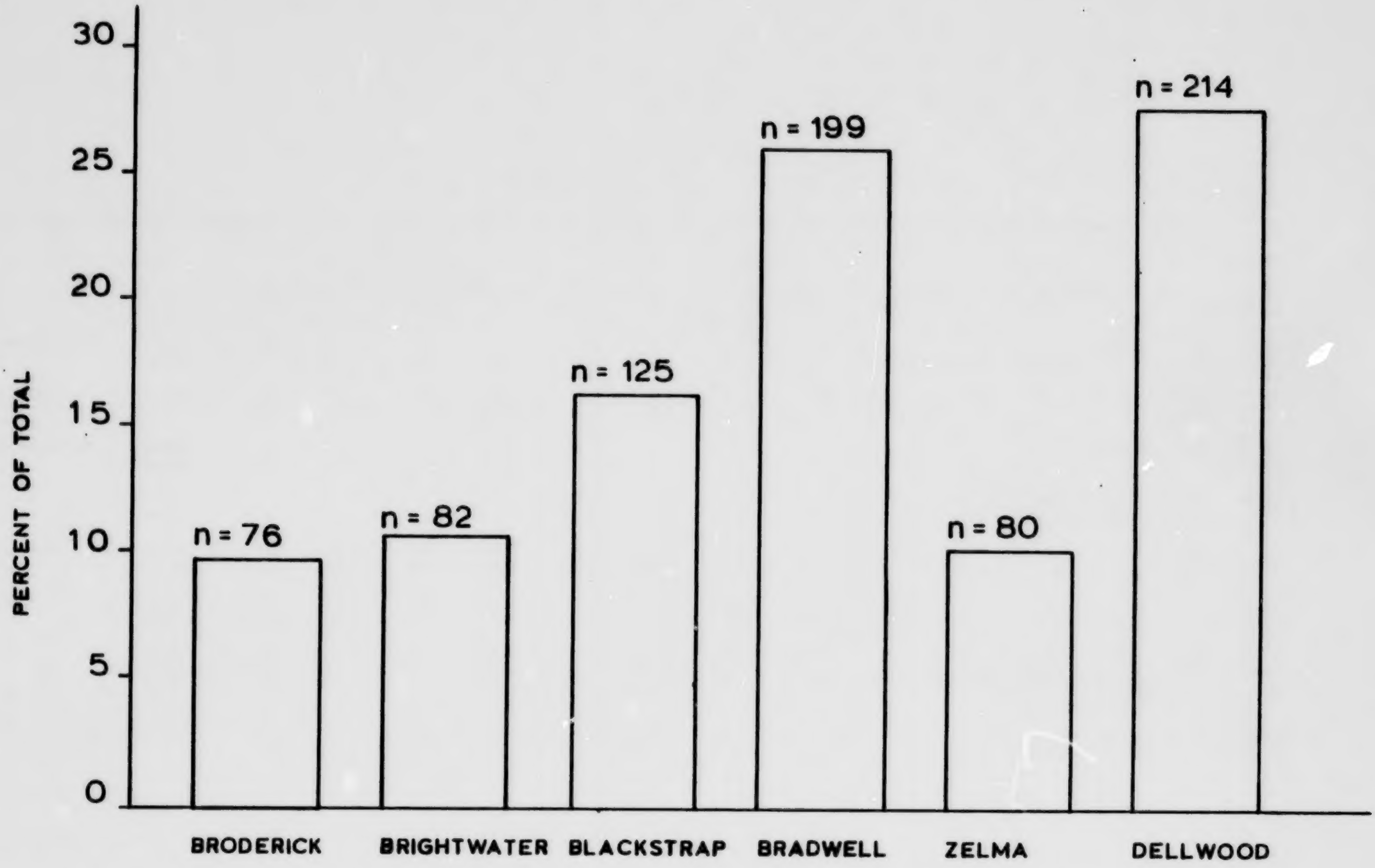


Fig. 38. Catch distribution of fish within the Saskatoon Southeast Water Supply System in 1988.

Table 15: Fishing effort and catch per unit effort in the 6 reservoirs of the Saskatoon Southeast Water Supply System in 1988.

| Reservoir | No. Net Sets | No. Fish | Catch/Unit Effort |
|---|---|---|---|
| Blackstrap | 3 | 125 | 41.67 |
| Bradwell | 2 | 199 | 99.50 |
| Brightwater | 2 | 82 | 41.0 |
| Broderick | 2 | 76 | 38.0 |
| Dellwood | 2 | 214 | 107.0 |
| Zelma | 2 | 80 | 40.0 |
| Total | 13 | 776 | 59.7 |

Table 16: Numbers and total weights (kg) of fish caught in gillnets in the 6 reservoirs of the Saskatoon Southeast Water Supply System in 1988.

| Species | | Broderick | | Brightwater | | Blackstrap | | Bradwell | | Zelma | | Dellwood | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | % | Total | % | Total | % | Total | % | Total | % | Total | % | Total | % |
| Common white sucker | number | - | - | 6 | 7.3 | 4 | 3.2 | 4 | 1.9 | 4 | 5.0 | 74 | 34.5 | 92 | 11.7 |
| | weight | - | - | 6.3 | 10.5 | 3.7 | 3.0 | 5.0 | 4.3 | 4.2 | 4.8 | 72.2 | 61.9 | 91.4 | 15.9 |
| Northern pike | number | 23 | 30.3 | 7 | 8.5 | 3 | 2.4 | 6 | 2.9 | 5 | 6.3 | - | - | 44 | 5.6 |
| | weight | 10.2 | 14.4 | 9.7 | 16.2 | 4.4 | 3.6 | 8.9 | 7.6 | 7.1 | 8.0 | - | - | 40.3 | 7.0 |
| Shorthead redhorse | number | - | - | 1 | 1.2 | - | - | - | - | - | - | - | - | 1 | 0.1 |
| | weight | - | - | 1.0 | 1.7 | - | - | - | - | - | - | - | - | 1.0 | 0.2 |
| Walleye | number | - | - | - | - | 82 | 65.6 | 21 | 10.0 | 29 | 36.2 | 132 | 61.7 | 264 | 33.6 |
| | weight | - | - | - | - | 53.8 | 43.4 | 15.4 | 13.2 | 32.8 | 37.2 | 40.8 | 35.0 | 142.8 | 24.8 |
| Lake whitefish | number | 41 | 53.9 | 32 | 39.0 | 36 | 28.8 | 48 | 23.0 | 41 | 51.3 | 4 | 1.9 | 202 | 25.7 |
| | weight | 56.0 | 79.1 | 38.7 | 64.8 | 62.0 | 50.0 | 64.3 | 55.1 | 43.2 | 49.0 | 2.8 | 2.4 | 267.0 | 46.3 |
| Yellow perch | number | 12 | 15.8 | 36 | 43.9 | - | - | 130 | 62.2 | 1 | 1.3 | 4 | 1.9 | 183 | 23.3 |
| | weight | 4.6 | 6.5 | 4.0 | 6.7 | - | - | 23.2 | 19.9 | 0.9 | 1.0 | 0.9 | 0.8 | 33.6 | 5.8 |
| Total | number | 76 | 9.7 | 82 | 10.4 | 125 | 15.9 | 209 | 26.6 | 80 | 10.2 | 214 | 27.2 | 786 | - |
| | weight | 70.8 | 12.3 | 59.7 | 10.4 | 123.9 | 21.5 | 116.8 | 20.3 | 88.2 | 15.3 | 116.7 | 20.3 | 576.1 | - |

The fourth most frequently encountered species was the common white sucker which comprised 11.7% of the total catch. Northern pike was the fifth most numerous species. Only one shorthead redhorse, taken from Brightwater Reservoir, was captured in the gillnets.

Seining was carried out in Broderick and Dellwood reservoirs only. It is interesting to note that species found in one reservoir were not encountered in the other (Table 17). Broderick Reservoir yielded the greater number of small fish and the larger diversity of species. Yellow perch caught here comprised 76.8% of the total catch. Common white suckers were the third most numerous species but comprised only 1.3% of the total catch. Northern pike and walleye combined made up less than 1%. Fathead minnows from Dellwood Reservoir were the second most abundant small fish encountered and formed 21.7% of the total catch.

#### 4.2.1.2.1 Walleye

A total of 264 walleye were captured in gillnets in 4 reservoirs of the Saskatoon Southeast Water Supply in 1988. Fifty percent of these were obtained from Dellwood Reservoir (Table 16). An additional 31% was captured in Blackstrap Reservoir. Eight percent and 11% of the total catch of walleye were caught in Bradwell and Zelma reservoirs, respectively. All four reservoirs were stocked in 1970 shortly after they were created. Bradwell and Zelma have not been stocked since. Stocking of Dellwood Reservoir resumed in 1986. Blackstrap has been stocked intermittently since 1970 (see Appendix 7). No walleye were caught in Broderick or Brightwater reservoirs. Neither of the latter have ever been stocked.

Length-frequency distributions of walleye from each of the 4 locations are shown in Figs. 39-42. Walleye caught in Dellwood tended

Table 17: Numbers and relative abundance of small fish caught by seining in Broderick and Dellwood reservoirs in 1988.

| Species | Broderick Reservoir | Dellwood Reservoir | Total | % |
|---|---|---|---|---|
| Yellow perch | 3000 | 0 | 3000 | 76.8 |
| Common white sucker | 51 | 0 | 51 | 1.3 |
| Northern pike | 5 | 0 | 5 | 0.1 |
| Walleye | 3 | 0 | 3 | <0.1 |
| Fathead minnow | 0 | 850 | 850 | 21.7 |
| Brook stickleback | 0 | 2 | 2 | <0.1 |
| Total | 3059 | 852 | 3909 | |
| % | 78 | 21.8 | | |

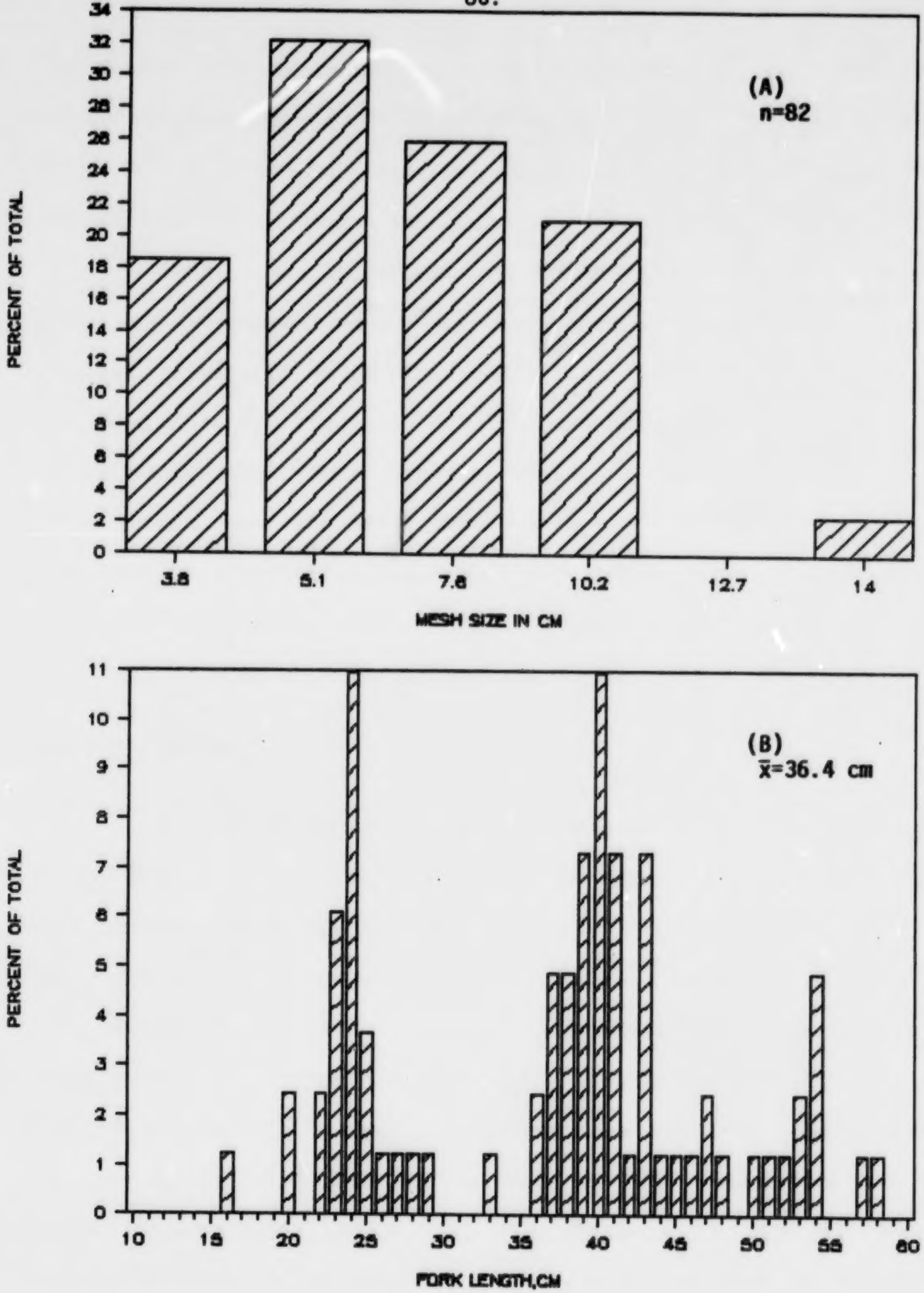


Fig. 39. Distribution of catch in various mesh sizes (A) and length-frequency distribution (B) of walleye caught in gillnets in Blackstrap Reservoir in 1988. (n=number of fish; $\bar{x}$=mean fork length).

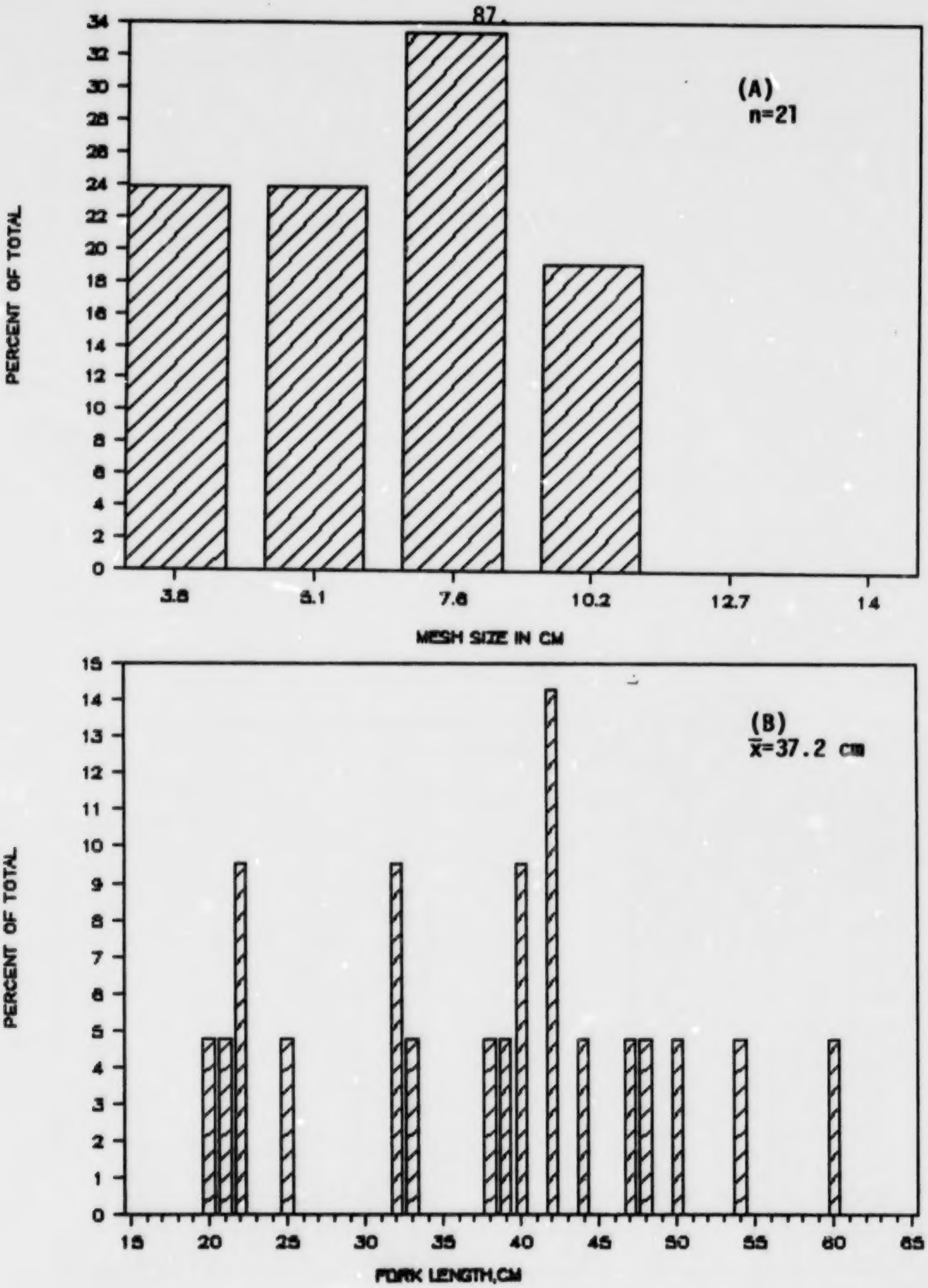


Fig. 40. Distribution of catch in various mesh sizes (A) and length-frequency distribution (B) of walleye caught in gillnets in Bradwell Reservoir in 1988. (n=number of fish; $\bar{x}$=mean fork length).

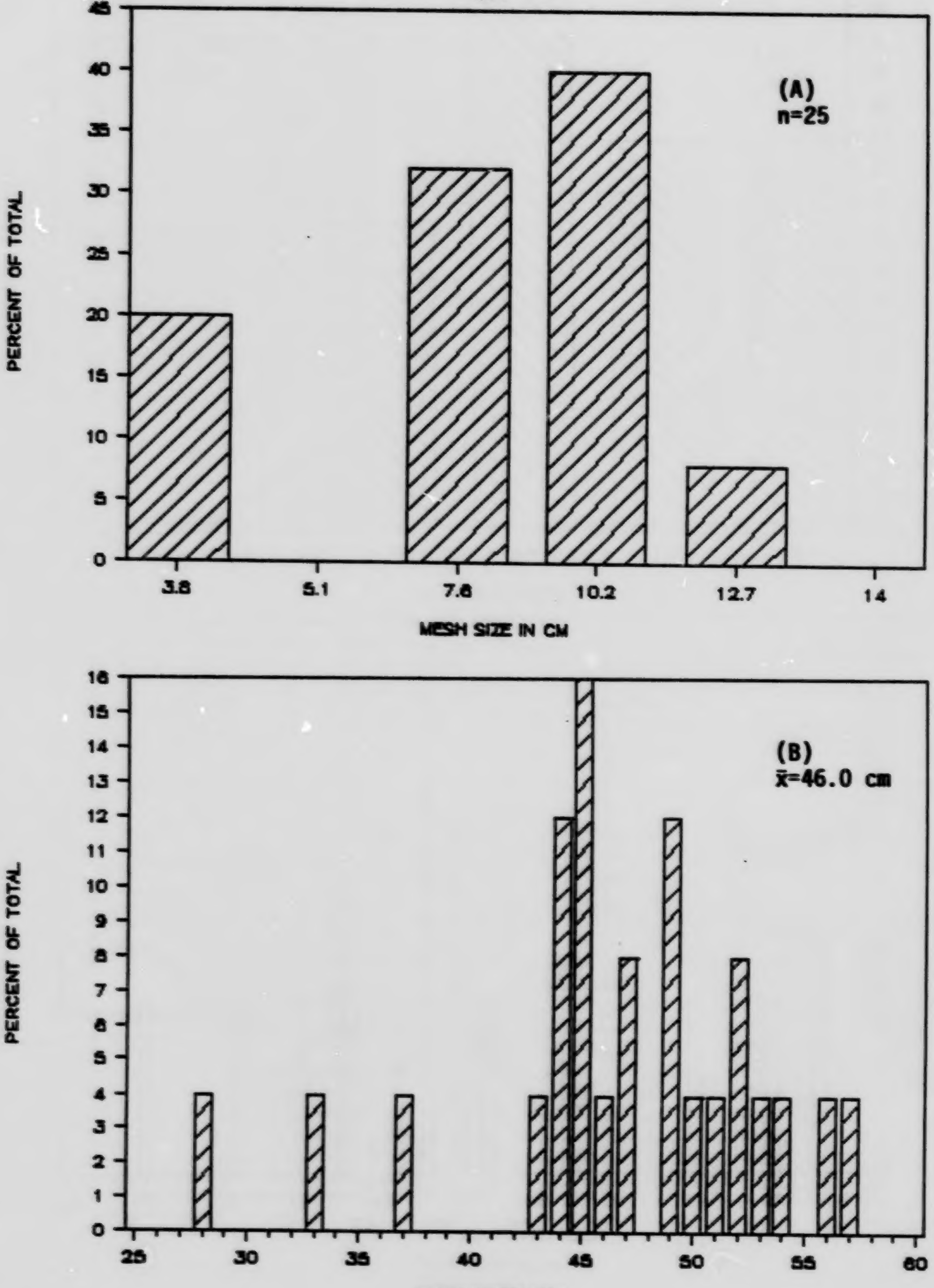


Fig. 41. Distribution of catch in various mesh sizes (A) and length-frequency distribution (B) of walleye caught in gillnets in Zelma Reservoir in 1988. (n=number of fish; x̄=mean fork length).

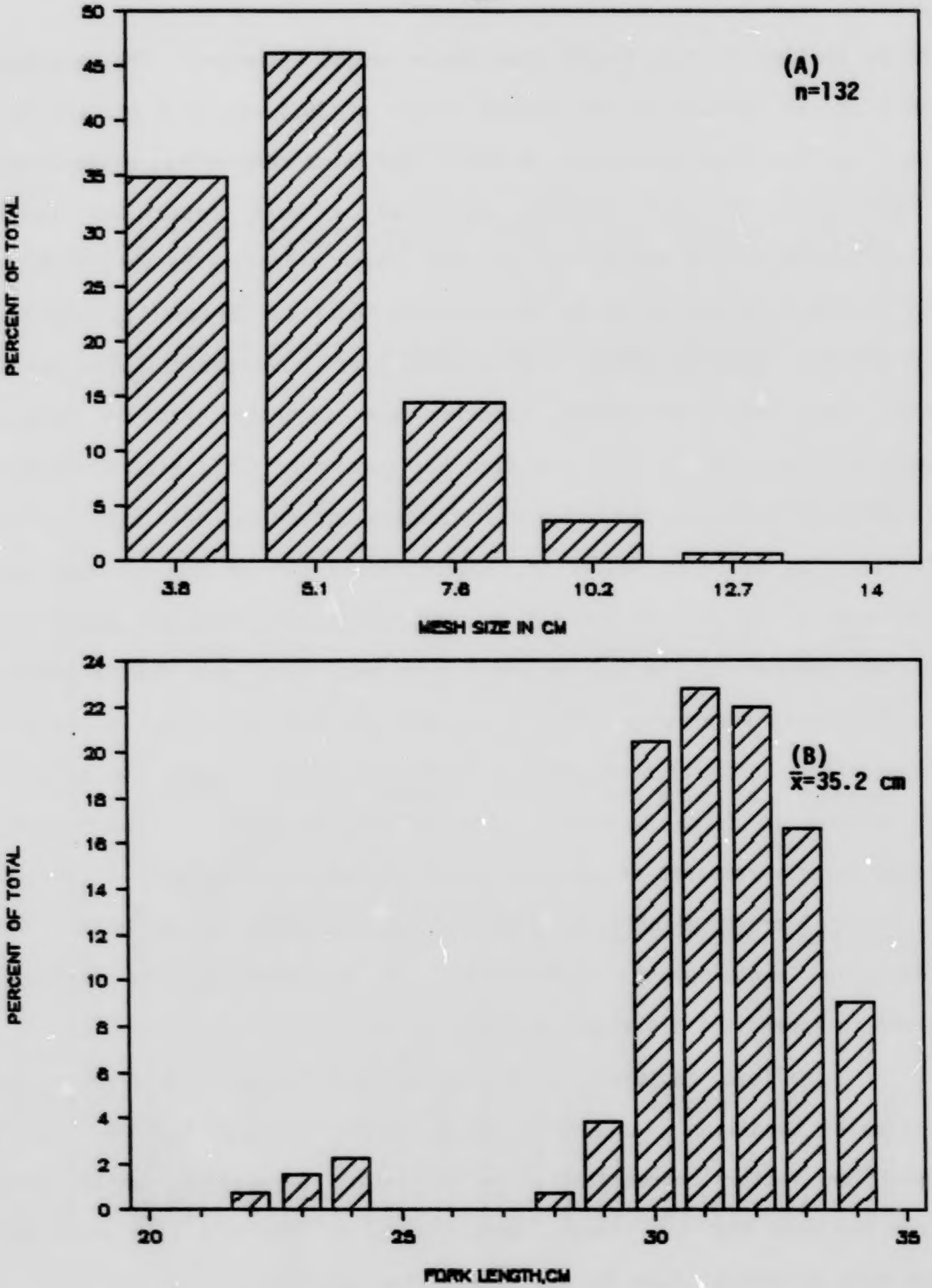


Fig. 42. Distribution of catch in various mesh sizes (A) and length-frequency distribution (B) of walleye caught in gillnets in Dellwood Reservoir in 1988. (n=number of fish; $\bar{x}$=mean fork length).

to be smaller in fork length than those caught elsewhere. They averaged 30.7 cm, as opposed to the average length of 36.4 cm, 37.2 cm, and 46.0 cm of walleye from Blackstrap, Bradwell and Zelma reservoirs, respectively (Table 18). Dellwood walleye exhibited a more restricted length distribution with a maximum and minimum length differing by only 11.8 cm, in contrast to the 41.9 cm (Blackstrap), 40.1 cm (Bradwell), and 29.2 cm (Zelma) range in sizes found in the other 3 reservoirs. The narrow size range reflects recent stocking and suggests that no natural reproduction from the 1970 stocking has occurred. This size difference is also reflected in the catch distribution in various mesh sizes (Figs. 39-42). In Dellwood Reservoir, approximately 80% of the walleye were captured in the 5.1 cm and 3.8 cm mesh sizes reflecting the small size of the specimens. The 5.1 cm and 7.6 cm mesh sizes were most effective in Blackstrap Reservoir. The 7.6 cm mesh was most effective in Bradwell Reservoir and the 7.6 cm and 10.2 cm mesh sizes caught the majority of walleye in Zelma Reservoir. The walleye in Zelma Reservoir appear to be largely remnants of the population introduced in 1970.

Average weights for these fish are shown in Table 18. The resulting length-weight relationships, as described by the equations given in Appendix 8 are shown in Figs. 43-46.

Walleye captured in Blackstrap and Bradwell reservoirs had a similar condition (Table 19). Those caught in Zelma had the highest condition factor representative of a mature population, while those from Dellwood had the lowest, more typical of immature fish which may not have sufficient food for the size of the population.

Food contents were examined in 132 walleye stomachs collected from Dellwood Reservoir. Midge larvae comprised 52% of the contents

Table 18: Summary of length/weight data for fish caught in gillnets in the 6 reservoirs of the Saskatoon Southeast Water Supply in 1988.

| Species | Length (cm) | | | Weight (g) | | |
|---|---|---|---|---|---|---|
| | Average | Maximum | Minimum | Average | Maximum | Minimum |
| BLACKSTRAP RESERVOIR | | | | | | |
| Common White Sucker | 39.1 | 42.0 | 34.0 | 912.5 | 1075 | 600 |
| Northern Pike | 58.4 | 68.0 | 52.1 | 1458.3 | 2150 | 1100 |
| Walleye | 36.4 | 57.5 | 15.6 | 669.5 | 2100 | 40 |
| Whitefish | 46.1 | 55.5 | 21.5 | 1723.1 | 2800 | 160 |
| BRADWELL RESERVOIR | | | | | | |
| Common White Sucker | 42.1 | 45.1 | 39.9 | 1256.2 | 1550 | 1050 |
| Northern Pike | 54.1 | 72.9 | 42.8 | 1491.6 | 3100 | 675 |
| Walleye | 37.2 | 59.9 | 19.8 | 733.3 | 2400 | 80 |
| Whitefish | 43.0 | 53.4 | 35.4 | 1340.1 | 2100 | 850 |
| Yellow Perch | 22.3 | 55.5 | 17.8 | 171.4 | 350 | 80 |
| BRIGHTWATER RESERVOIR | | | | | | |
| Common White Sucker | 47.1 | 52.8 | 40.0 | 1575.0 | 2050 | 925 |
| Northern Pike | 51.3 | 90.2 | 36.8 | 1389.2 | 5500 | 375 |
| Whitefish | 39.4 | 54.6 | 22.8 | 1208.5 | 2800 | 175 |
| Yellow Perch | 19.7 | 50.2 | 13.2 | 1149.3 | 420 | 30 |
| Shorthead Redhorse | 41.2 | 41.2 | 41.2 | 1050.0 | 1050 | 1050 |
| BRODERICK RESERVOIR | | | | | | |
| Northern Pike | 37.1 | 61.6 | 24.2 | 445.0 | 2050 | 90 |
| Whitefish | 43.4 | 56.6 | 20.7 | 1365.8 | 3000 | 120 |
| Yellow Perch | 42.7 | 54.8 | 24.0 | 379.5 | 550 | 230 |
| DELLWOOD RESERVOIR | | | | | | |
| Common White Sucker | 38.9 | 49.5 | 29.6 | 975.6 | 1825 | 375 |
| Walleye | 30.7 | 33.8 | 22.0 | 309.2 | 425 | 110 |
| Whitefish | 35.2 | 36.0 | 34.2 | 716.6 | 850 | 600 |
| Yellow Perch | 42.6 | 51.3 | 32.0 | 1393.7 | 1800 | 625 |
| ZELMA RESERVOIR | | | | | | |
| Common White Sucker | 40.3 | 43.5 | 36.2 | 1050.0 | 1250 | 850 |
| Northern Pike | 57.7 | 61.7 | 55.1 | 14230.0 | 1700 | 1075 |
| Walleye | 46.0 | 56.4 | 27.2 | 1312.0 | 2300 | 200 |
| Whitefish | 40.5 | 55.5 | 24.6 | 1270.0 | 3000 | 230 |
| Yellow Perch | 36.0 | 36.0 | 36.0 | 900.0 | 900 | 900 |
| RESERVOIR SUMMARY | | | | | | |
| Common White Sucker | 39.5 | 52.8 | 29.6 | 1015.2 | 2050 | 375 |
| Northern Pike | 45.4 | 90.2 | 24.2 | 917.8 | 5500 | 90 |
| Walleye | 34.5 | 59.9 | 15.6 | 553.5 | 2400 | 40 |
| Whitefish | 42.4 | 56.6 | 20.7 | 1369.4 | 3000 | 120 |
| Yellow Perch | 41.5 | 55.5 | 13.2 | 241.9 | 3000 | 200 |
| Shorthead Redhorse | 41.2 | 41.2 | 41.2 | 1050.0 | 1050 | 1050 |

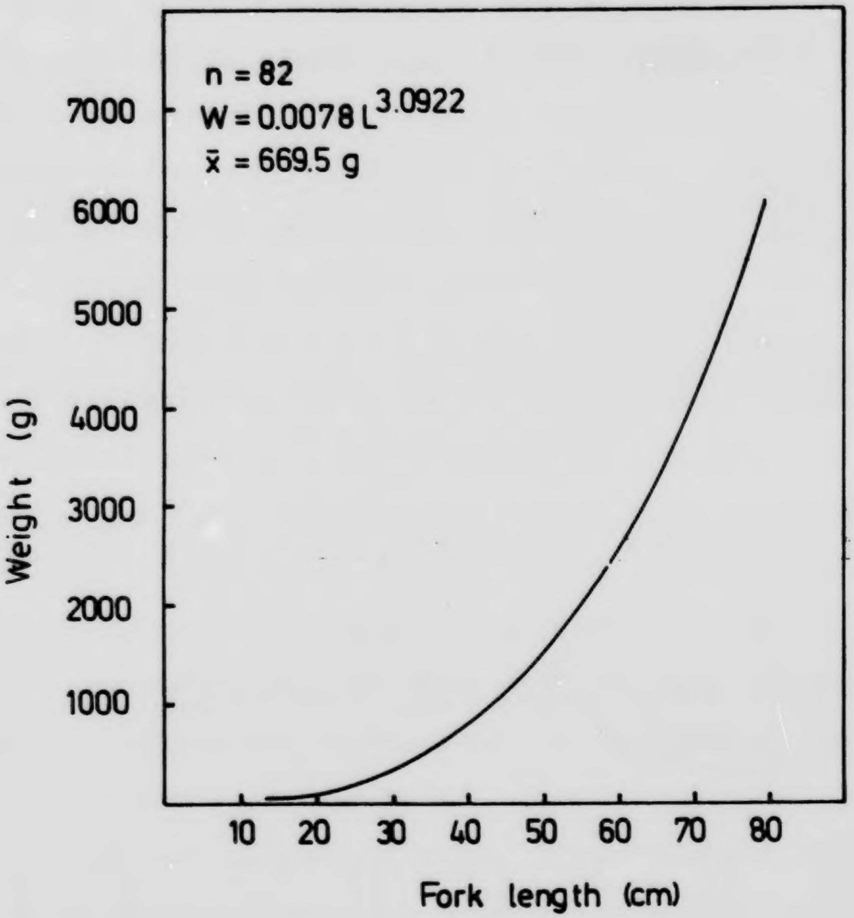


Fig. 43. Length-weight relationship of walleye caught in gillnets in Blackstrap Reservoir in 1988. (n=number of fish; $\bar{x}$=mean weight)

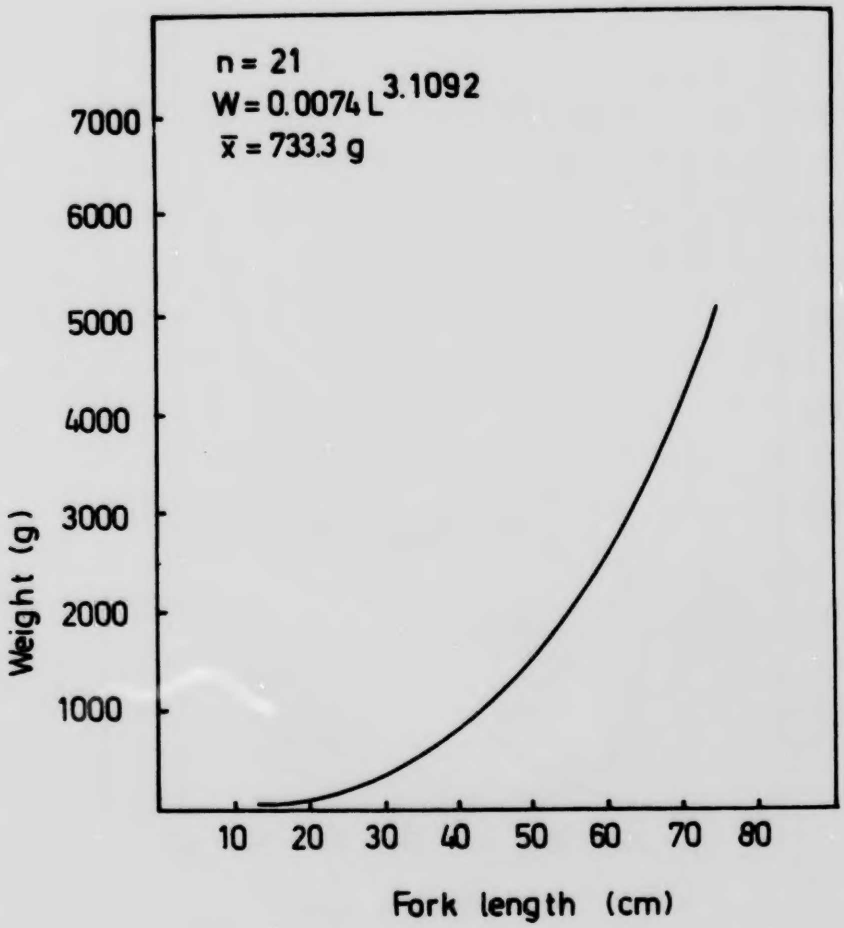


Fig. 44. Length-weight relationship of walleye caught in gillnets in Bradwell Reservoir in 1988. (n=number of fish; x̄=mean weight)

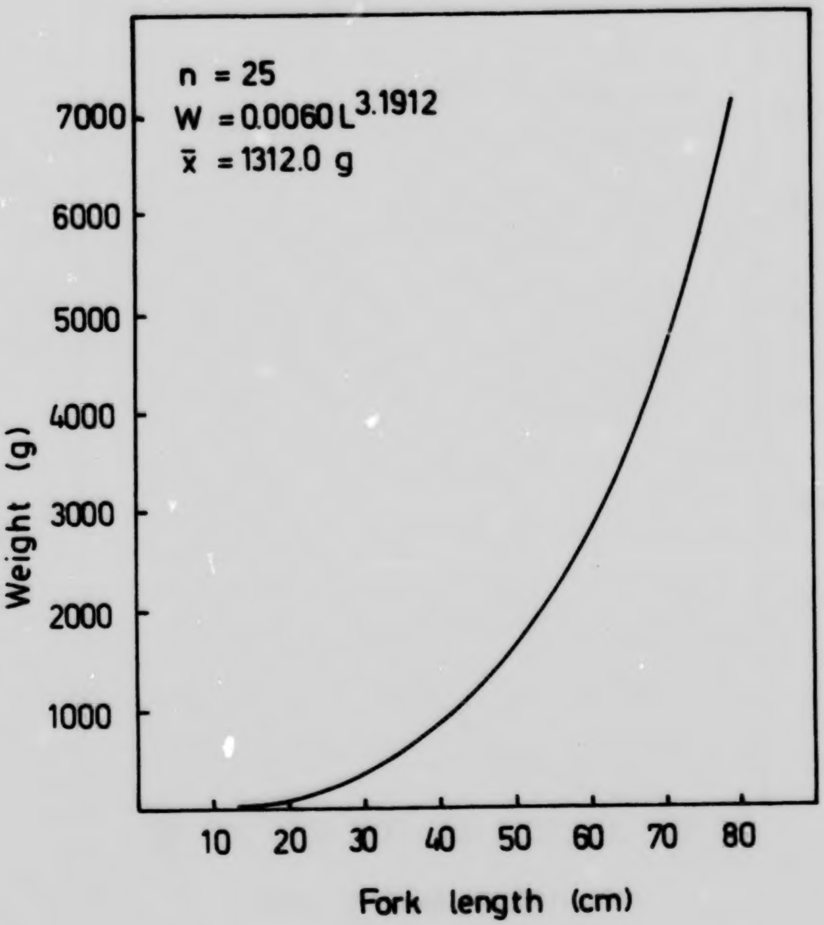


Fig. 45. Length-weight relationship of walleye caught in gillnets in Zelma Reservoir in 1988. (n=number of fish; $\bar{x}$=mean weight)

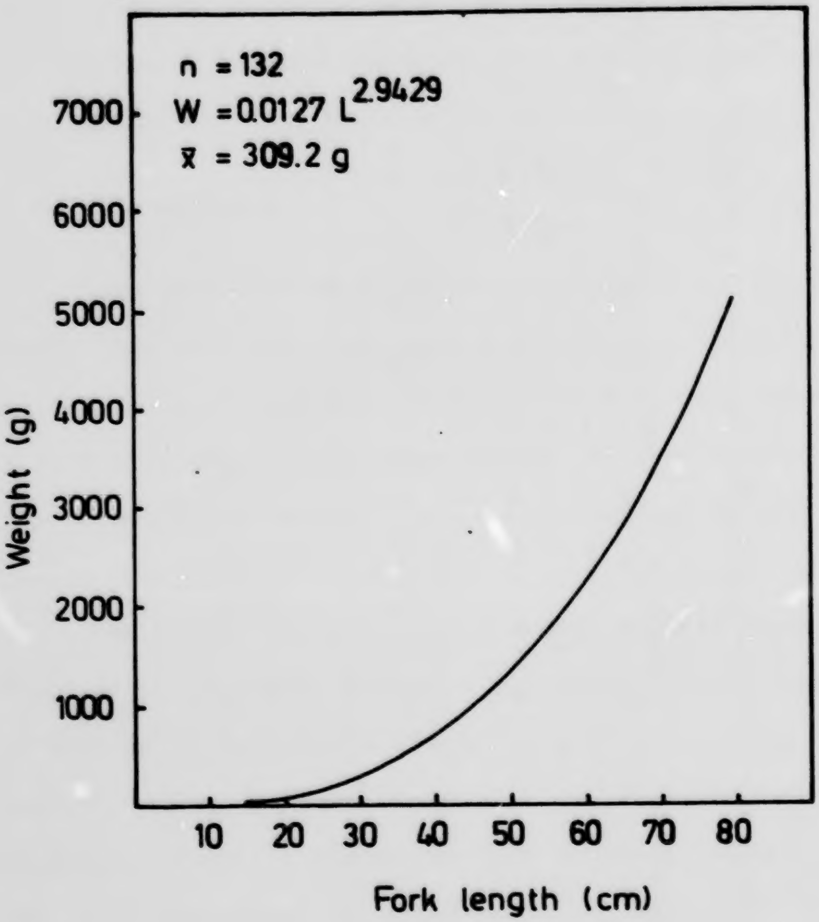


Fig. 46. Length-weight relationship of walleye caught in gillnets in Dellwood Reservoir in 1988. (n=number of fish; $\bar{x}$=mean weight)

Table 19: Coefficients of condition (K) of 6 fish species caught in gillnets in the 6 reservoirs of the Saskatoon Southeast Water Supply System in 1988.

| Species | Blackstrap | | | Bradwell | | | Brightwater | | | Broderick | | | Dellwood | | | Zelma | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | K | SD[1] | No. | K | SD | No. | K | SD | No. | K | SD | No. | K | SD | No. | K | SD |
| Common white sucker | 4 | 1.49 | ±0.05 | 4 | 1.67 | ±0.44 | 4 | 1.46 | ±0.09 | - | - | - | 74 | 1.60 | ±0.12 | 4 | 1.59 | ±0.12 |
| Northern pike | 3 | 0.71 | ±0.05 | 6 | 0.83 | ±0.02 | 7 | 0.76 | ±0.02 | 23 | 0.70 | ±0.14 | - | - | - | 5 | 0.73 | ±0.05 |
| Lake whitefish | 36 | 1.67 | ±0.12 | 48 | 1.66 | ±0.19 | 32 | 1.69 | ±0.14 | 41 | 1.48 | ±0.15 | 4 | 1.65 | ±0.13 | 34 | 1.78 | ±0.35 |
| Shorthead redhorse | - | - | - | - | - | - | 1 | 1.50 | - | - | - | - | - | - | - | - | - | - |
| Walleye | 82 | 1.10 | ±0.13 | 21 | 1.11 | ±0.05 | - | - | - | - | - | - | 132 | 1.05 | ±0.06 | 29 | 1.26 | ±0.11 |
| Yellow perch | - | - | - | 21 | 1.47 | ±0.15 | 9 | 1.52 | ±0.14 | 12 | 1.66 | ±0.09 | 4 | 1.81 | ±0.08 | 1 | 1.93 | - |

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1 - standard deviation

of the 92 stomachs containing food (Table 20). Water boatmen and fish remains (primarily brook sticklebacks) made up 7% and 6%, respectively. Unidentified food stuff made up 30% of the stomach content. In Blackstrap Reservoir, 45 walleye stomachs were examined for food remains. Leeches were the primary dietary constituent, comprising 70% of the contents of the 31 stomachs containing food. Mayfly nymphs made up the remainder. Only 2 of the 4 stomachs examined from Bradwell Reservoir contained any food remains and these could not be identified.

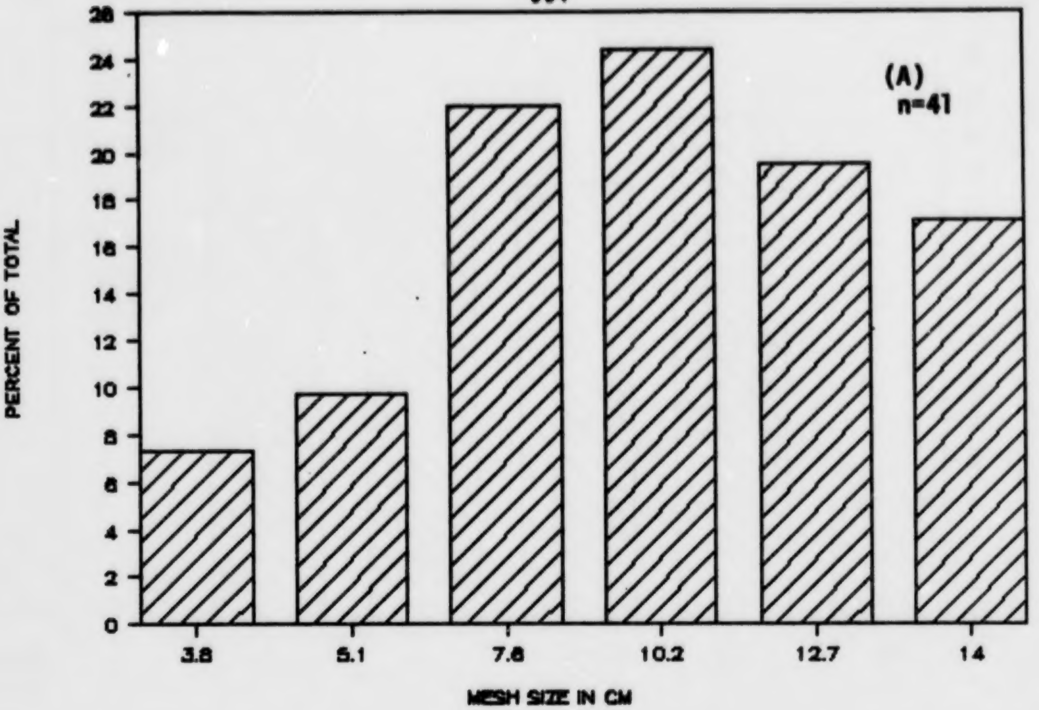
#### 4.2.1.2.2 Lake Whitefish

Lake whitefish were caught in gillnets in all 6 reservoirs in 1988. They were relatively evenly distributed, in terms of numbers in all but Dellwood Reservoir where only 4 fish were taken (Table 16). Since none are known to have been stocked in these reservoirs they were apparently introduced as fry from Lake Diefenbaker by way of the canal system.

The length-frequency distributions of this species are shown in Figs. 47-51 (Dellwood Reservoir excluded). Sizes ranged from 20.7 cm to 56.6 cm in fork length (Table 18) with the average length within a reservoir being anywhere from 39.4 cm (Brightwater) to 46.1 cm (Blackstrap). Overall, whitefish from Bradwell Reservoir tended to be the most consistent in size (with the exception of those from Dellwood), with fork lengths ranging from 35.4 cm to 53.4 cm. The 7.6 cm and 10.2 cm mesh sizes of gillnet were the most effective in catching whitefish in the Broderick, Blackstrap, and Zelma reservoirs (Figs. 47-51). Whitefish from Bradwell tended to be more vulnerable to the 10.2 cm and 12.7 cm mesh sizes even though size differences were not

Table 20: Occurrence of food items in the stomachs of walleye caught in gillnets in 3 reservoirs of the Saskatoon Southeast Water Supply System in 1988. (% composition by volume).

| | Bradwell | Blackstrap | Dellwood |
|---|---|---|---|
| No. sampled | 4 | 45 | 132 |
| No. with food | 2 | 31 | 92 |
| Fish remains | - | - | 6 |
| Chironomidae | - | - | 52 |
| Corixidae | - | - | 7 |
| Ephemeroptera | - | 30 | - |
| Odonata | - | - | 5 |
| Hirudinea | - | 70 | 0.2 |
| Unidentified | 100 | - | 30 |



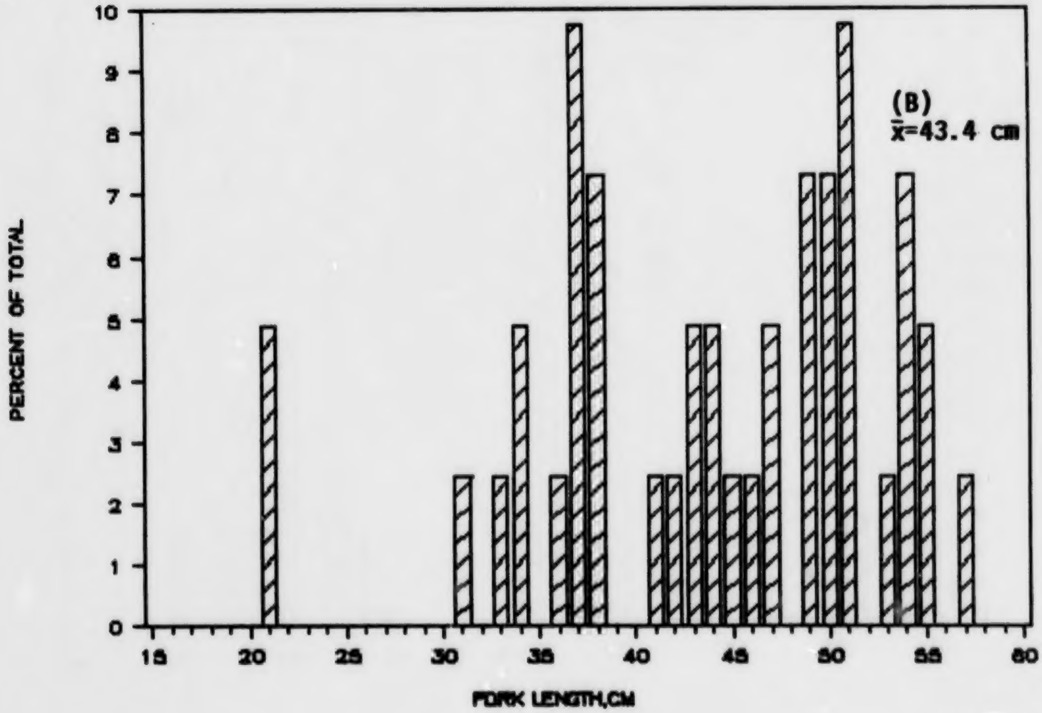
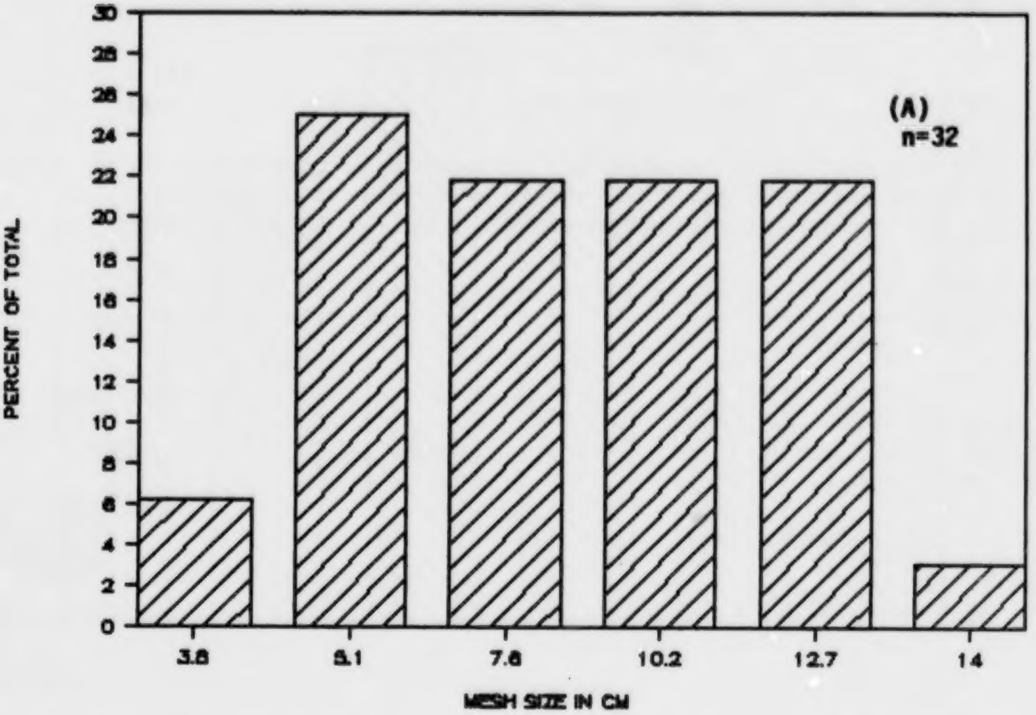


Fig. 47. Distribution of catch in various mesh sizes (A) and length-frequency distribution (B) of lake whitefish caught in gillnets in Broderick Reservoir in 1988. (n=number of fish; $\bar{x}$=mean fork length).



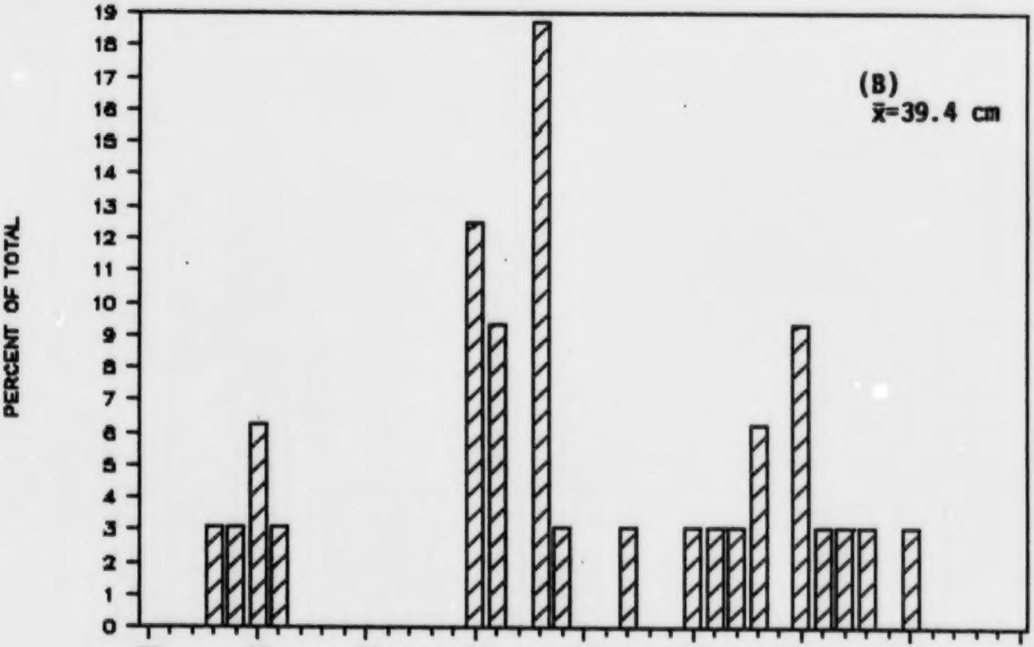


Fig. 48. Distribution of catch in various mesh sizes (A) and length-frequency distribution (B) of lake whitefish caught in gillnets in Brightwater Reservoir in 1988. (n=number of fish; $\bar{x}$=mean fork length).

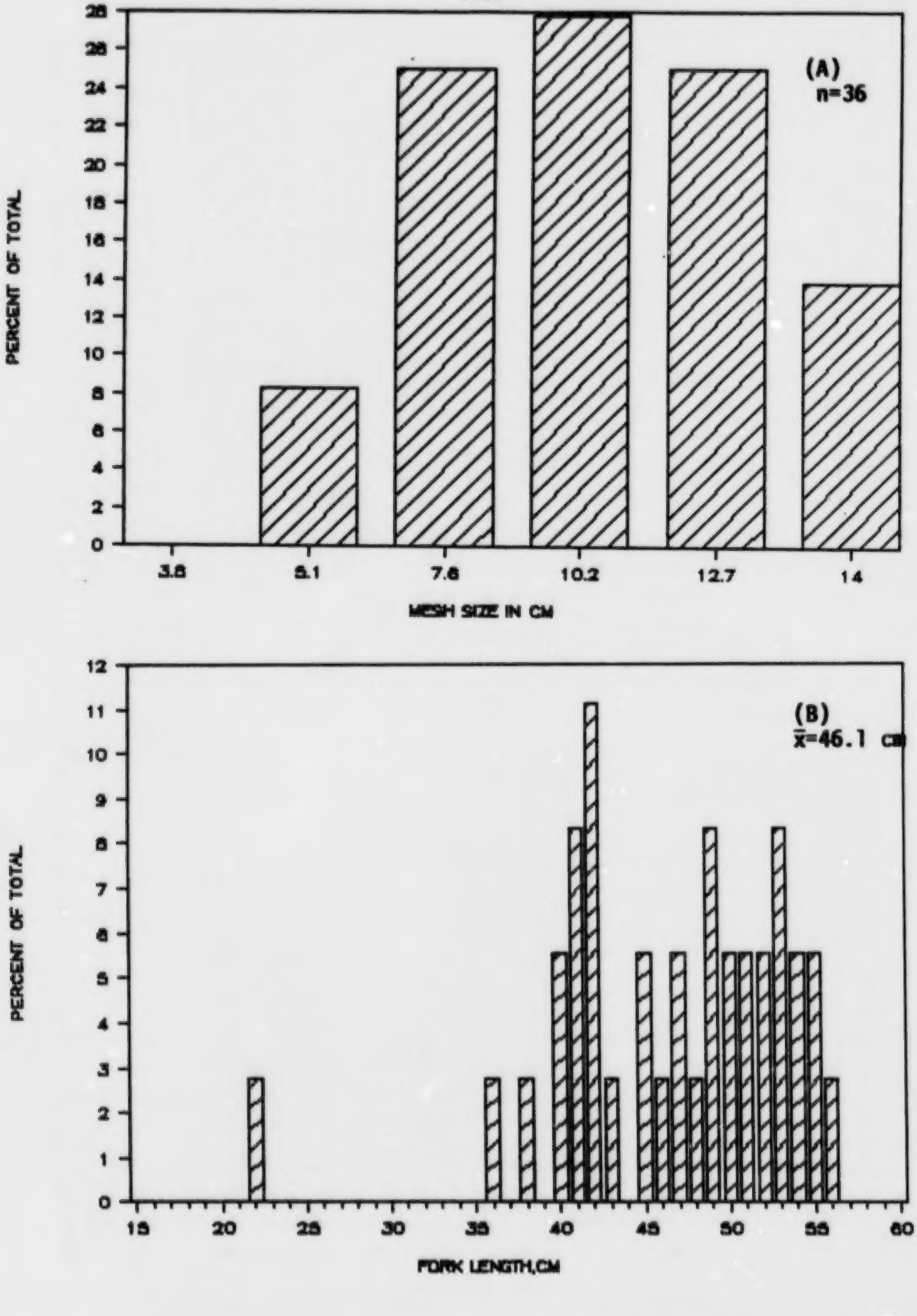


Fig. 49. Distribution of catch in various mesh sizes (A) and length-frequency distribution (B) of lake whitefish caught in gillnets in Blackstrap Reservoir in 1988. (n=number of fish; $\bar{x}$=mean fork length).

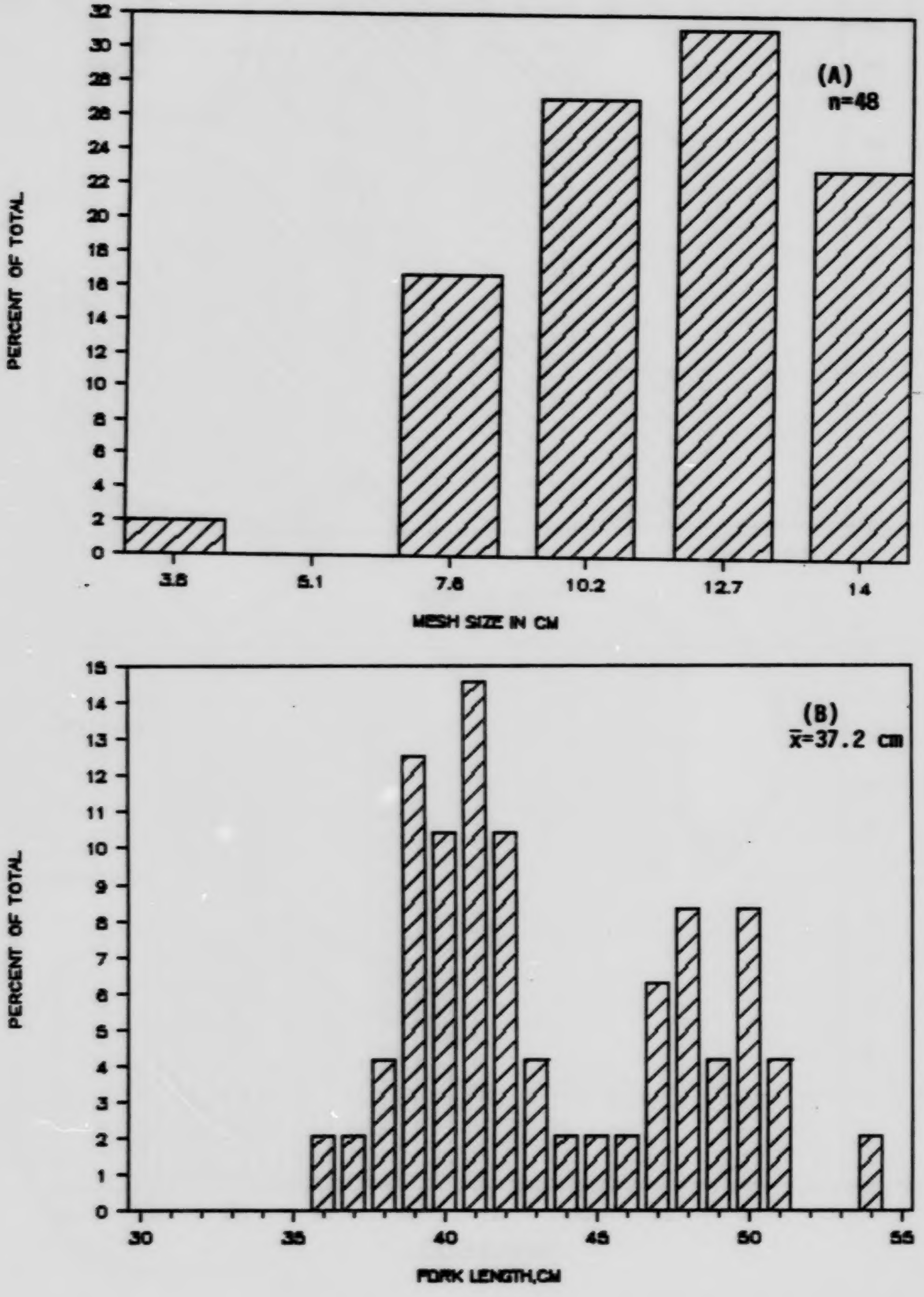


Fig. 50. Distribution of catch in various mesh sizes (A) and length-frequency distribution (B) of lake whitefish caught in gillnets in Bradwell Reservoir in 1988. (n=number of fish; x̄=mean fork length).

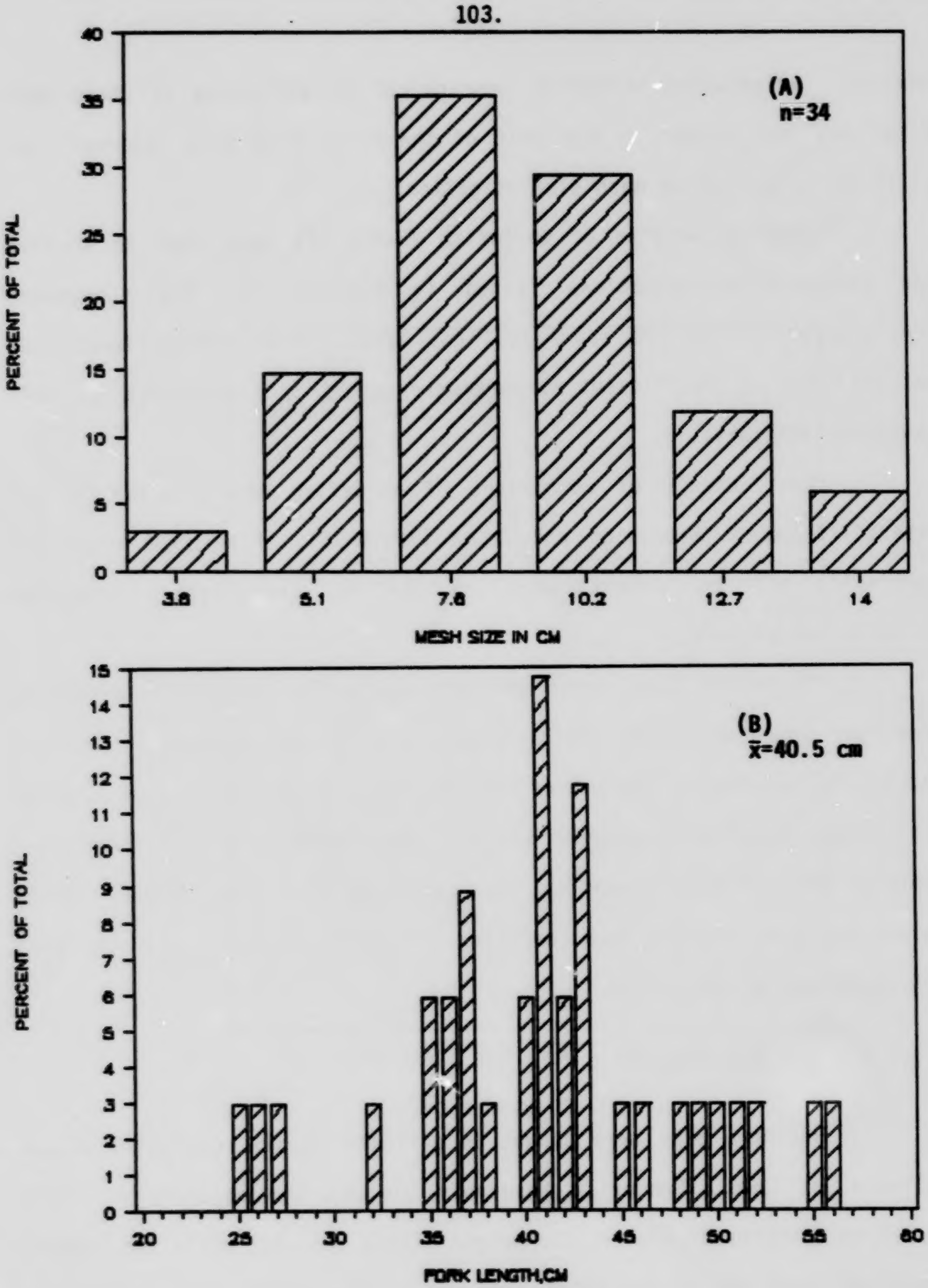


Fig. 51. Distribution of catch in various mesh sizes (A) and length-frequency distribution (B) of lake whitefish caught in gillnets in Zelma Reservoir in 1988. (n=number of fish; $\bar{x}$=mean fork length).

obvious. Brightwater whitefish were caught in all three of these mesh sizes but the largest single unit of the catch from this reservoir was captured in the 5.1 cm mesh size of gillnet.

Average weights of whitefish (Table 18) were used to develop the length-weight equations listed in Appendix 8. The subsequent length-weight curves are shown in Figs. 52-56. Fish from Dellwood were not included as insufficient numbers were caught to establish a reliable length-weight curve.

Coefficients of conditions of whitefish were similar in all reservoirs except Broderick and Zelma (Table 19). Fish from these two reservoirs had the lowest condition (K=1.48) and highest condition (K=1.78), respectively.

Preferred food items of lake whitefish caught in Broderick Reservoir appeared to be snails (Table 21). These organisms comprised 82% of the volumetric content of the 15 stomachs containing food. Other food items included freshwater shrimp. Four stomachs of lake whitefish captured in Dellwood Reservoir were examined for food items. Midge larvae and water boatmen each comprised 40% of the content. The remaining 20% could not be identified.

#### 4.2.1.2.3 Northern Pike

Northern pike were caught in gillnets in all reservoirs except Dellwood in 1988. Broderick Reservoir yielded the majority of these fish both in terms of numbers and weight (Table 16), but while the numbers comprised over 50% of the total pike catch, the weight contributed only 25%. Figure 57 shows that most fish were between 30 cm and 35 cm in fork length. Average length, however, was determined to be 37.1 cm

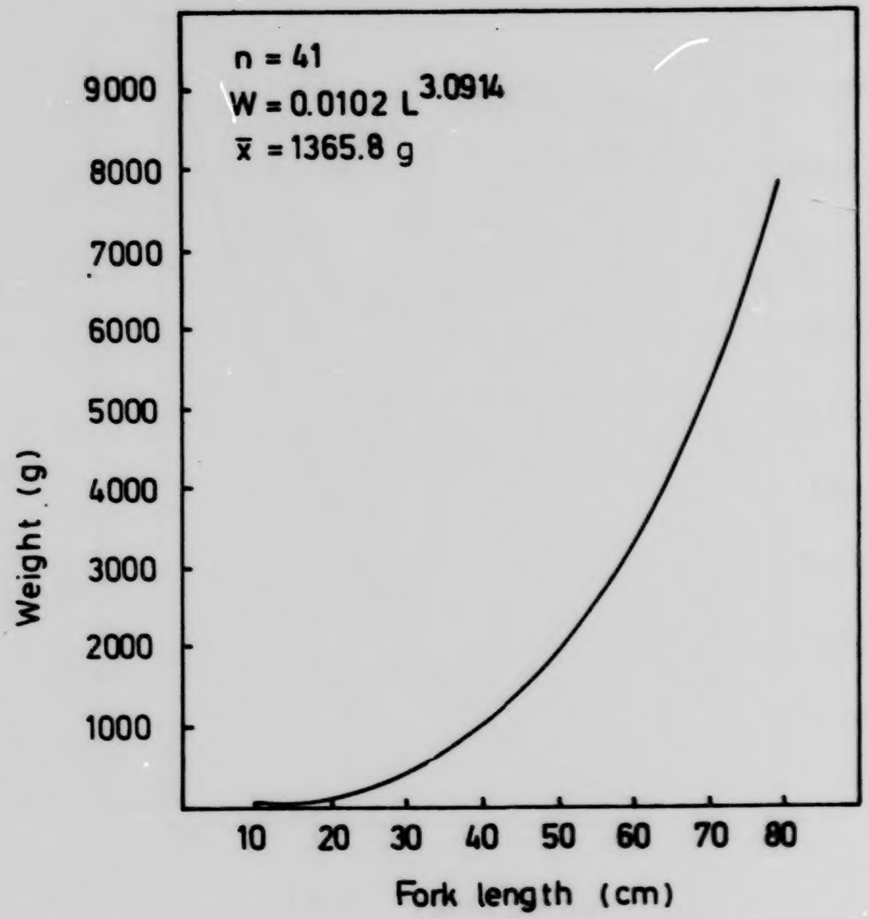


Fig. 52. Length-weight relationship of lake whitefish caught in gillnets in Broderick Reservoir in 1988. (n= number of fish; $\bar{x}$=mean weight).

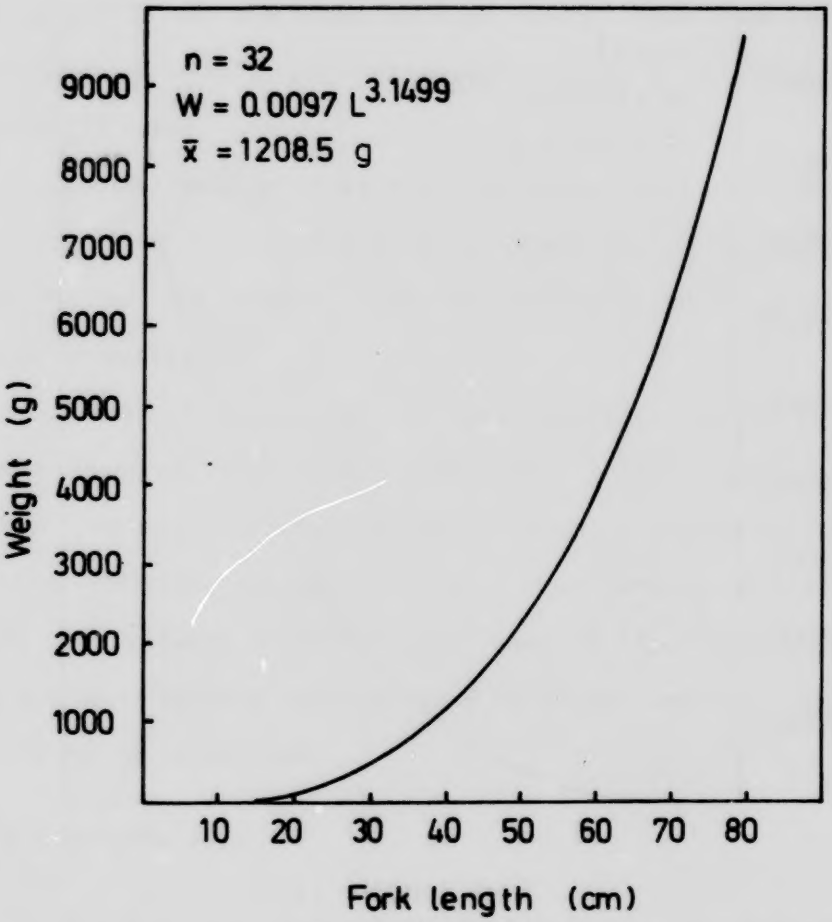


**Fig. 53.** Length-weight relationship of lake whitefish caught in gillnets in Brightwater Reservoir in 1988. (n=number of fish; $\bar{x}$=mean weight).

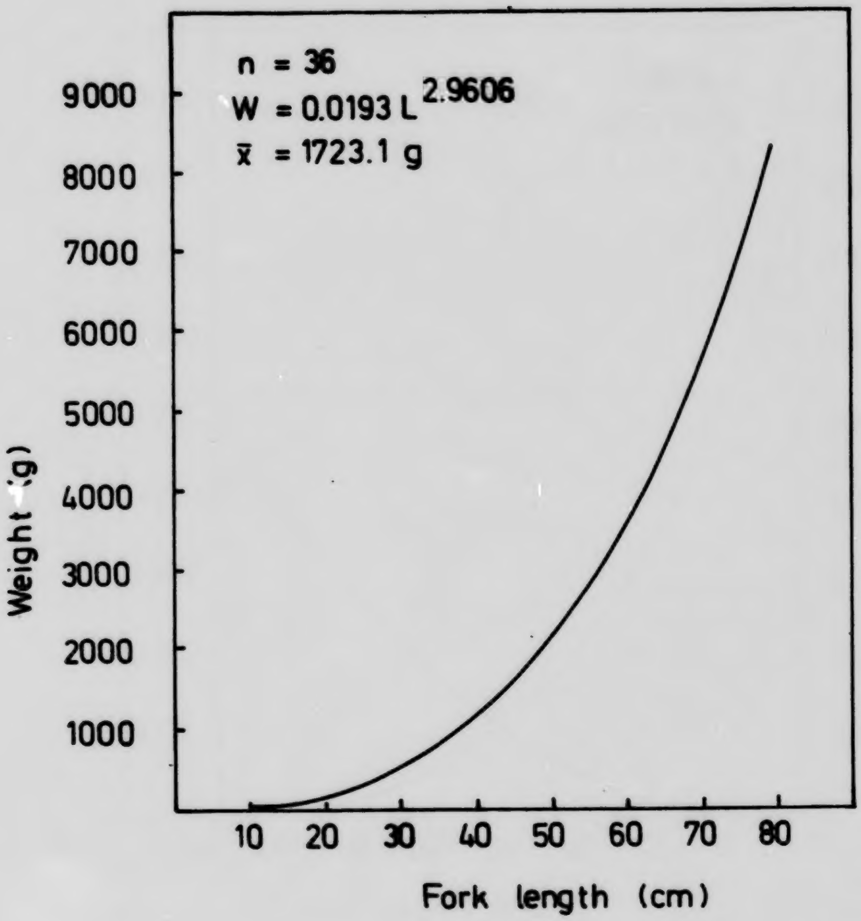


Fig. 54. Length-weight relationship of lake whitefish caught in gillnets in Blackstrap Reservoir in 1988. (n=number of fish; x̄=mean weight).

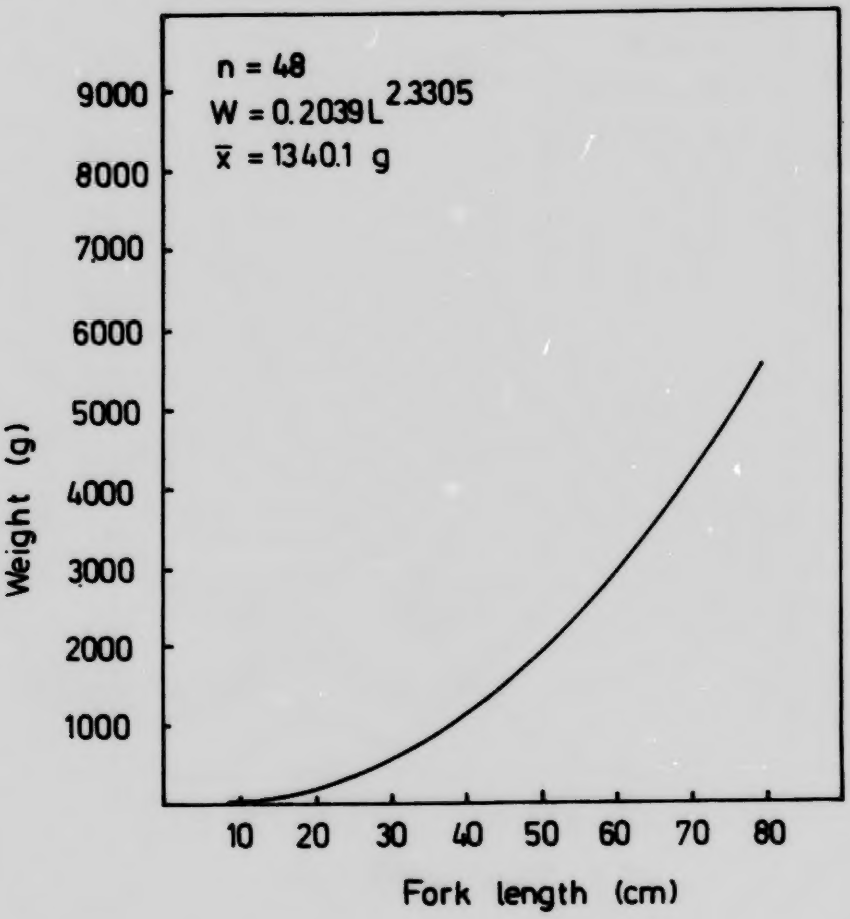


Fig. 55. Length-weight relationship of lake whitefish caught in gillnets in Bradwell Reservoir in 1988. (n=number of fish; $\bar{x}$=mean weight).

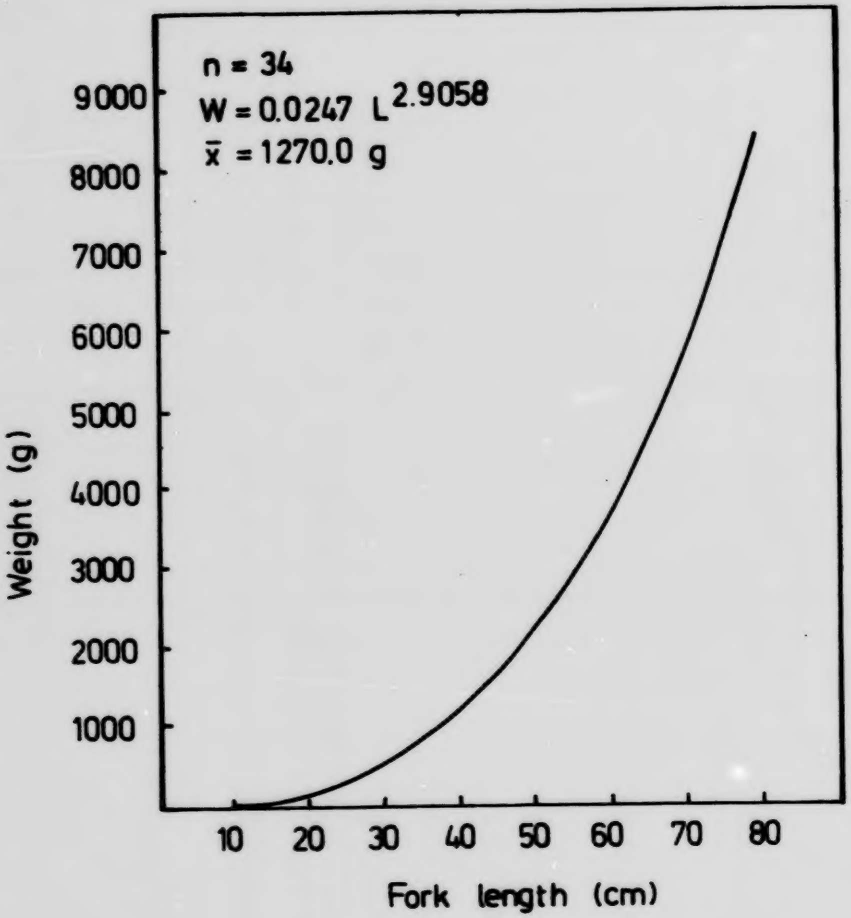


Fig. 56. Length-weight relationship of lake whitefish caught in gillnets in Zelma Reservoir in 1988. (n=number of fish; $\bar{x}$=mean weight).

Table 21: Occurrence of food items in the stomachs of lake whitefish captured in gillnets in 2 reservoirs of the Saskatoon Southeast Water Supply System in 1988. (% composition by volume).

| | Broderick | Dellwood |
|---|---|---|
| No. sampled | 41 | 4 |
| No. with food | 15 | 3 |
| Chironomidae | - | 40 |
| Corixidae | - | 40 |
| Gastropoda | 82 | - |
| Amphipoda | 12 | - |
| Unidentified | 6 | 20 |

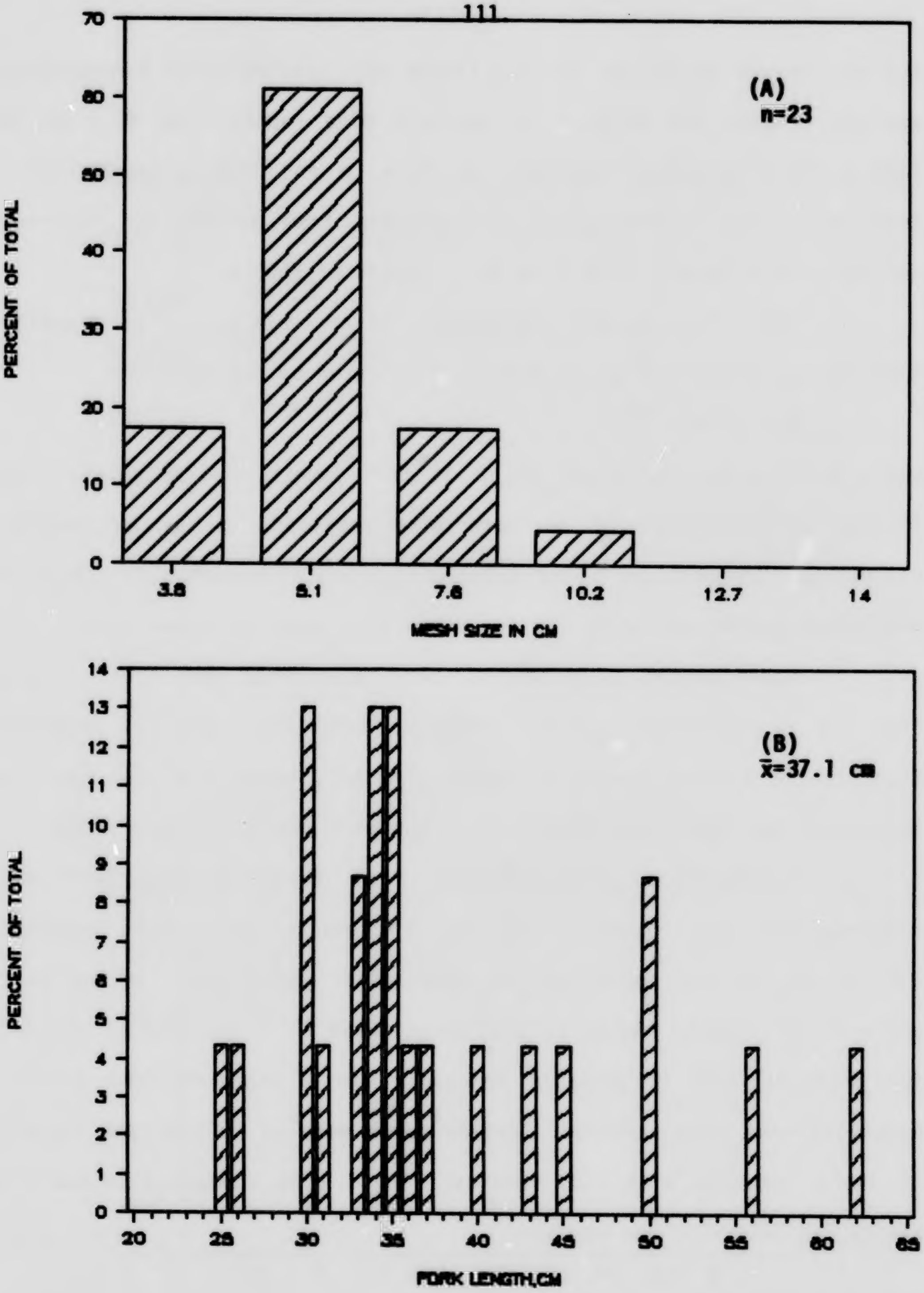


Fig. 57. Distribution of catch in various mesh sizes (A) and length-frequency distribution (B) of northern pike caught in gillnets in Broderick Reservoir in 1988. (n=number of fish; $\bar{x}$=mean fork length).

and the average weight was 445.0 g (Table 18). In the other 4 reservoirs, average lengths and weights of northern pike ranged from 51.3 cm and 1389 g in Brightwater Reservoir to 58.4 cm and 1458 g in Blackstrap Reservoir. The largest pike was obtained from Brightwater Reservoir and had a fork length of 90.2 cm and a weight of 5500 g.

The length-weight relationship of northern pike from Broderick Reservoir is shown in Fig. 58 and is illustrated by the equation:

$$W=0.0052L^{3.0714}$$

where W is weight in grams and L is fork length in centimeters. Due to the small numbers of northern pike captured in the Brightwater, Blackstrap, Bradwell and Zelma Reservoirs, length-frequency distributions and length-weight relationships for these fish were not established.

Coefficients of condition were calculated for northern pike from the 5 reservoirs and are shown in Table 19. Bradwell Reservoir fish had the highest condition factor (K=0.83); those from the remaining reservoirs had lower condition factors but were similar to each other.

Twenty-three pike stomachs from Broderick Reservoir were examined for food remains. Of the 5 stomachs containing foodstuff, 93% of the volume could not be identified (Table 22). Yellow perch and dragonfly nymphs (Odonata) each constituted 3% of the stomach content. Two stomachs from Brightwater Reservoir and 2 stomachs from Bradwell Reservoir were also examined. Yellow perch made up 100% of the contents of the 3 stomachs with food remains. The 1 pike stomach examined from Blackstrap Reservoir was empty.

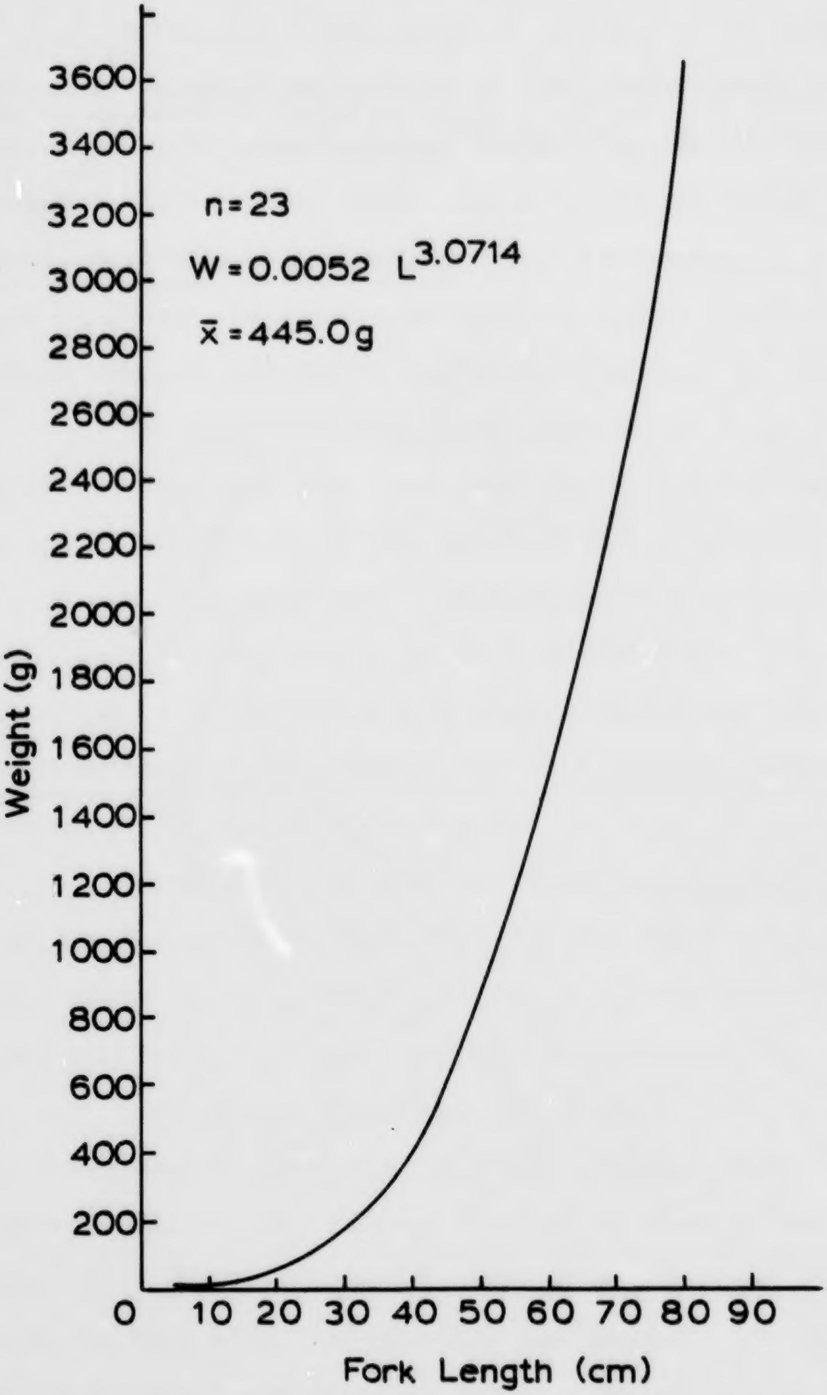


Fig. 58. Length-weight relationship of northern pike caught in gillnets in Broderick Reservoir in 1988. (n=number of fish; $\bar{x}$=mean weight).

Table 22: Occurrence of food items in the stomachs of northern pike caught in gillnets in 4 reservoirs of the Saskatoon Southeast Water Supply System in 1988. (% composition by volume).

| | Broderick | Brightwater | Bradwell | Blackstrap |
|---|---|---|---|---|
| No. sampled | 23 | 2 | 2 | 1 |
| No. with food | 5 | 1 | 2 | 0 |
| Fish remains (Yellow perch) | 3 | 100 | 100 | - |
| Odonata | 3 | - | - | - |
| Unidentified | 93 | - | - | - |

### 4.2.1.2.4 Yellow Perch

Yellow perch were caught in gillnets in all reservoirs except Blackstrap and comprised 23.3% of the total catch (Table 16). Sixty-nine percent of this catch was from Bradwell Reservoir. Gillnets set in Broderick, Dellwood and Zelma reservoirs yielded 12, 4, and 1 yellow perch, respectively. Insufficient length and weight data were obtained from these fish and those taken from Brightwater Reservoir to establish length-frequency distributions or length-weight curves.

The length-frequency distribution of yellow perch from Bradwell Reservoir (Fig. 59) shows that over 60% of the fish were between 21 cm and 23 cm in fork length, and were most effectively caught in the 3.8 cm mesh size of gillnet. Sizes ranged from 17.8 cm to 55.5 cm in fork length with an average of 22.3 cm (Table 18). Average weight was determined to be 171.4 g and was used to obtain the equation describing the length-weight relationship for this species (Appendix 8). This relationship is illustrated in Fig. 60.

Coefficients of condition were calculated for yellow perch from the 5 reservoirs (Table 19). The one perch from Zelma Reservoir had a higher condition factor (K=1.93) than those fish caught elsewhere. Perch from Bradwell reservoir had the lowest condition factor (K=1.47).

Occurrence of food items was examined in 12 stomachs of yellow perch captured in Broderick Reservoir. Mayfly nymphs (Ephemeroptera) comprised 48% of the contents of the 3 stomachs with food remains (Table 23). Snails (Gastropoda) made up an additional 28%. Other food items included midge (Chironomidae) and caddisfly (Trichoptera) larvae. The 4 stomachs examined from Dellwood Reservoir all contained food remains. Midge larvae comprised 90% of the content and freshwater shrimp (Amphipoda) made up the remainder.

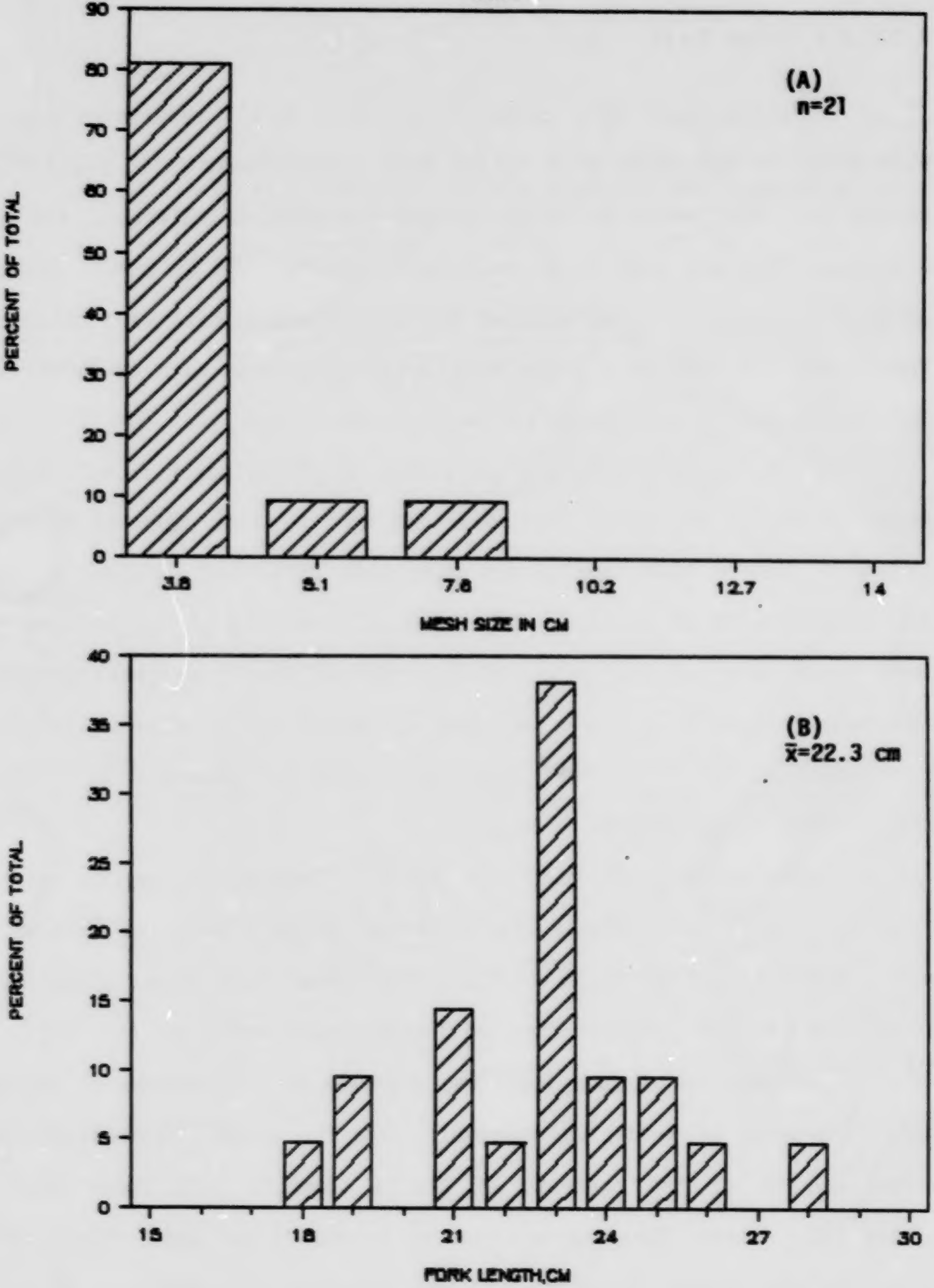


Fig. 59. Distribution of catch in various mesh sizes (A) and length-frequency distribution (B) of yellow perch caught in gillnets in Bradwell Reservoir in 1988. (n=number of fish; $\bar{x}$=mean fork length).

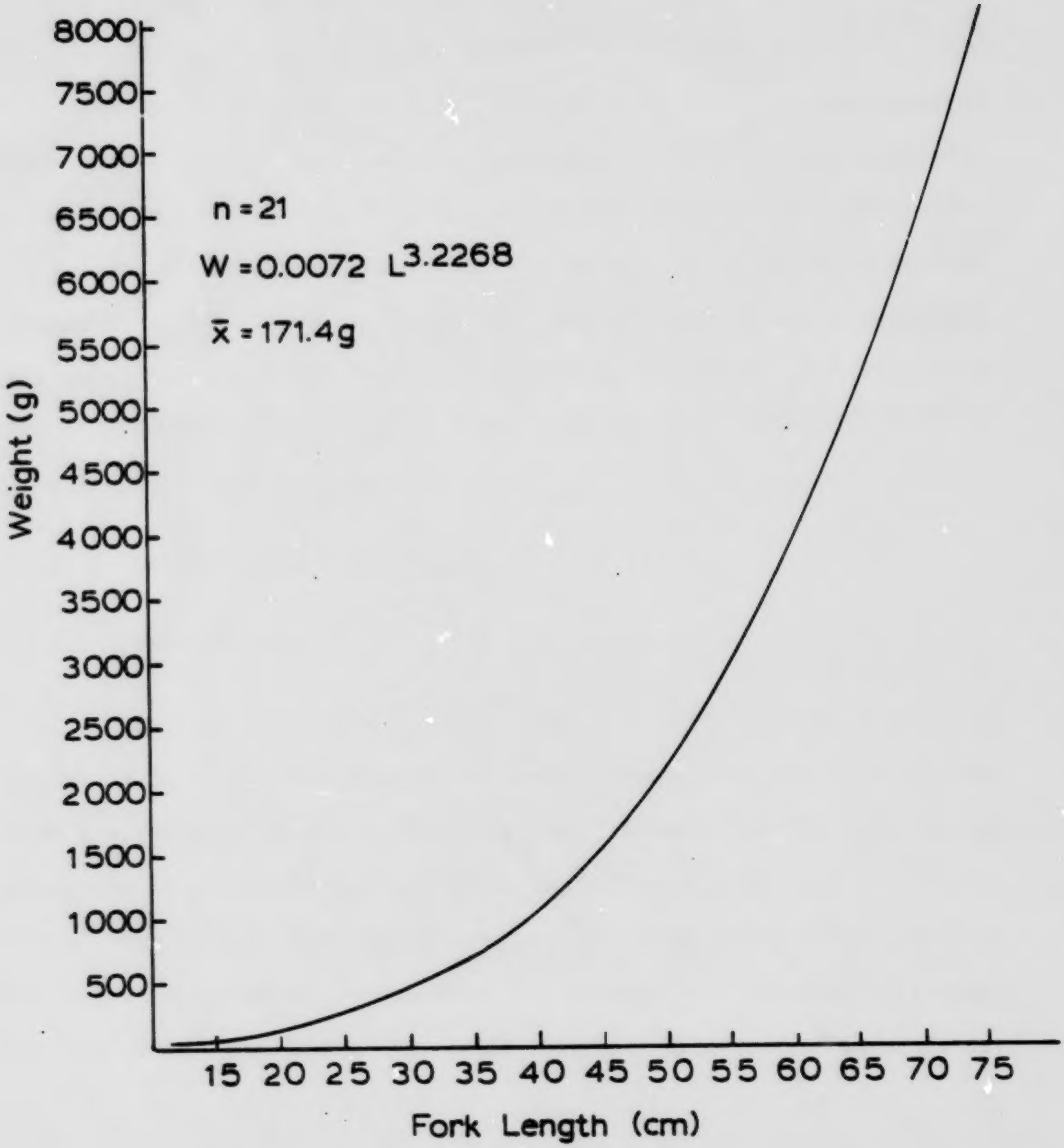


Fig. 60. Length-weight relationship of yellow perch caught in gillnets in Bradwell Reservoir in 1988. (n=number of fish; $\bar{x}$=mean weight).

Table 23: Occurrence of food items in the stomachs of yellow perch caught in gillnets in 3 reservoirs of the Saskatoon Southeast Water Supply System in 1988. (% composition by volume).

| | Broderick | Dellwood | Bradwell |
|---|---|---|---|
| No. sampled | 12 | 4 | 1 |
| No. with food | 3 | 4 | 0 |
| Chironomidae | 19 | 90 | - |
| Ephemeroptera | 48 | - | - |
| Trichoptera | 5 | - | - |
| Gastropoda | 28 | - | - |
| Amphipoda | - | 10 | - |

#### 4.2.1.2.5 Common White Sucker

Common white suckers were caught in all the reservoirs except Broderick and comprised 11.7% of the total gillnet catch in 1988 (Table 16). Dellwood Reservoir yielded 80% of the total sucker catch. Approximately 70% of this was captured in the 7.6 cm and 10.2 cm mesh sizes of gillnet (Fig. 61).

Sizes of common white suckers in Dellwood Reservoir ranged from 29.6 cm to 49.5 cm in fork length (Table 18) with the majority being within the 38 cm to 41 cm range (Fig. 61). Average length was determined to be 38.9 cm and average weight was 975.6 g (Table 18).

Coefficients of condition for common white suckers from the 5 reservoirs are shown in Table 19. Suckers from Dellwood and Zelma reservoirs had a similar condition factor as did those from Blackstrap and Brightwater reservoirs. Suckers from Bradwell Reservoir had the highest condition factor (K=1.67).

## 4.2.2 Swift Current Creek System

### 4.2.2.1 Invertebrates

Benthic invertebrate fauna sampled by Ekman dredge and Surber sampler in Swift Current Reservoir, Duncairn Reservoir, and Swift Current Creek are shown in Table 24. Midge larvae, freshwater shrimp, and leeches were found in all sampling locations. Midge larvae comprised the largest single group of organisms encountered and were most prevalent in Duncairn Reservoir. Freshwater shrimp were the second most abundant organism, and dominated the catch in Swift Current Reservoir. Caddisflies,

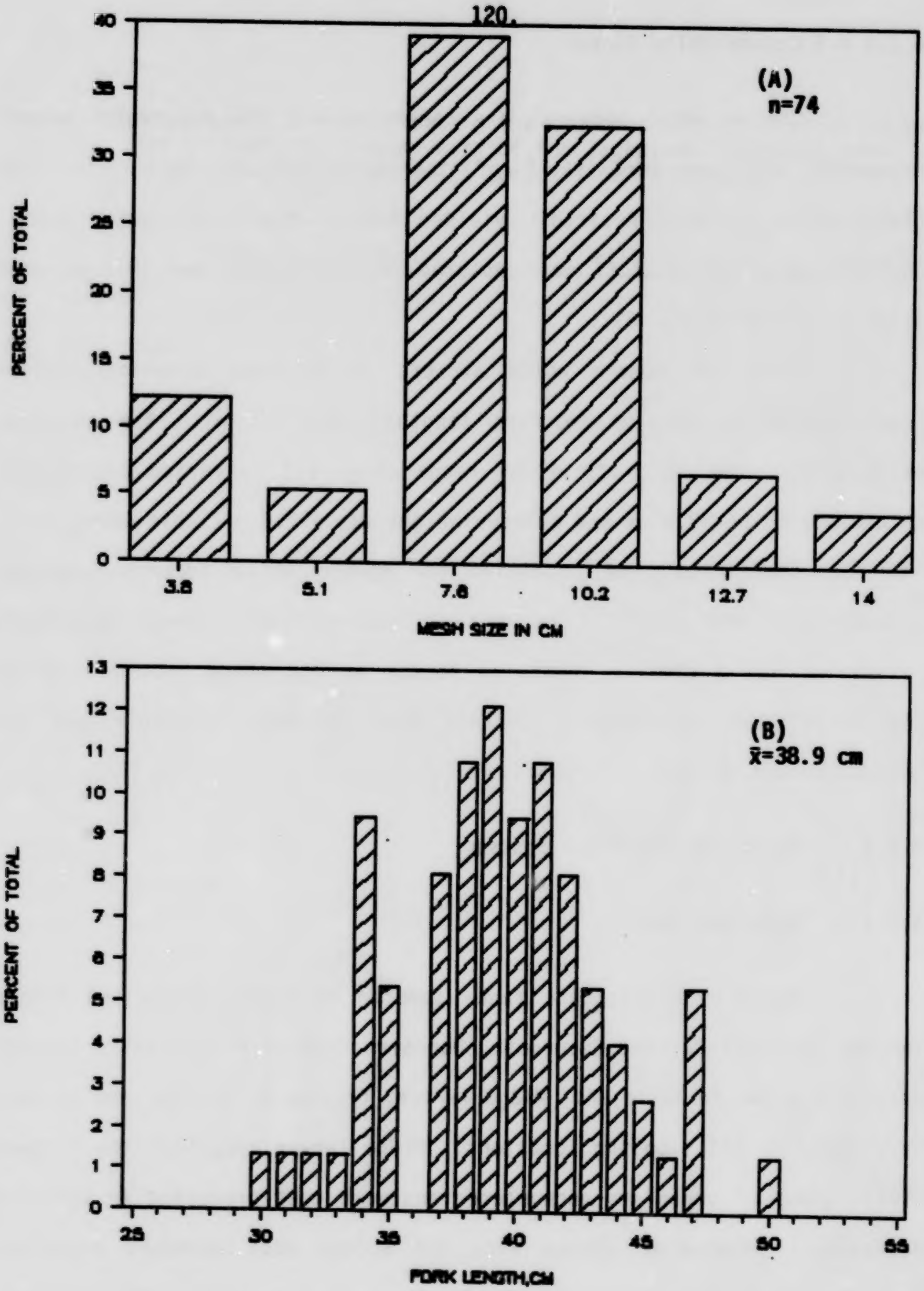


Fig. 61. Distribution of catch in various mesh sizes (A) and length-frequency distribution (B) of common white suckers caught in gillnets in Dellwood Reservoir in 1988. (n=number of fish; $\bar{x}$=mean fork length).

Table 24: Average numbers and weight of invertebrate fauna sampled by Ekman dredge and Surber sampler in the Swift Current Creek System in 1988.

| | Duncairn[1] Reservoir | Swift[1] Current Reservoir | Swift[2] Current Creek |
|---|---|---|---|
| Ephemeroptera | | | |
| Ephemeridae | - | 0.50 | - |
| Trichoptera | | | |
| Hydropsychidae | - | - | 22.00 |
| Polycentropidae | - | 0.25 | - |
| Other | - | - | 1.00 |
| Diptera | | | |
| Chironomidae | 544.26 | 10.25 | 4.50 |
| Other | 0.17 | - | 0.50 |
| Coleoptera | | | |
| Haliplidae | - | - | 8.50 |
| Hemiptera | | | |
| Corixidae | 3.33 | - | - |
| Hirudinea | 3.33 | 0.75 | 0.50 |
| Amphipoda | 9.83 | 119.00 | 4.50 |
| Sphaeriidae | - | - | 0.50 |
| Gastropoda | - | - | 1.00 |
| Oligochaeta | 2.33 | - | 1.00 |
| Total no. | 563.17 | 130.75 | 44.00 |
| No. samples | 6 | 4 | 2 |
| Wet weight, mg | 8146.67 | 1347.50 | 415.00 |
| Dry weight, kg $ha^{-1}$ | 444.36 | 91.87 | 5.35 |

[1] - Ekman Dredge

[2] - Surber Sampler

particularly the family Hydropsychidae, ranked third in numbers and were collected only at the mouth of Swift Current Creek where they comprised 50% of the catch for that site.

The total number of benthic fauna captured was 11 022·m$^{-2}$. Standing crop of organisms ranged from 5.35 kg·ha$^{-1}$ at the mouth of Swift Current Creek to 444.36 kg·ha$^{-1}$ in Duncairn Reservoir (Table 24). Average standing biomass was determined to be 182.65 kg·ha$^{-1}$.

### 4.2.2.2 Fish Species

Six species of fish were collected by gillnetting and seining in 3 locations on the Swift Current Creek system in 1988. These included walleye, northern pike, yellow perch, common white sucker, shorthead redhorse, longnose dace, and brook sticklebacks.

Five species, comprising a total of 349 fish, were caught in the gillnets. Duncairn Reservoir yielded 67% of this catch (Table 25). Six nets were set at this site in contrast to only one at each of the other two sites, however, the catch per unit effort was lower (Table 26).

Walleye were the most frequently encountered fish in the gillnets and made up 37% of the total catch (Table 25). Common white suckers and northern pike ranked second and third in terms of numbers, comprising 26.4% and 15.5% of the total catch, respectively. In Swift Current Reservoir and Swift Current Creek, these two species were prevalent.

Seining was carried out in Swift Current Creek and yielded approximately 60 common white sucker fingerlings, 30 brook sticklebacks, and 3 longnose dace.

Table 25: Numbers and total weights [1](kg) of fish caught in gillnets in 3 locations in the Swift Current Creek System in 1988.

| | | Duncairn Reservoir | | Swift Current Reservoir | | Swift Current Creek | | Total | % |
|---|---|---|---|---|---|---|---|---|---|
| Species | | Total | % | Total | % | Total | % | | |
| Common white sucker | number | 47 | 20.1 | 30 | 8.6 | 15 | 4.3 | 92 | 26.4 |
| | weight | 45.6 | 16.2 | - | - | - | - | 45.6[2] | |
| Northern pike | number | 19 | 8.1 | 23 | 6.6 | 12 | 3.4 | 54 | 15.5 |
| | weight | 39.8 | 14.1 | 9.2 | 2.7 | 35.1 | 10.5 | 84.1 | |
| Shorthead redhorse | number | 19 | 8.1 | 0 | - | 24 | 6.9 | 43 | 12.3 |
| | weight | 20.4 | 7.2 | - | - | - | - | 20.4[2] | |
| Walleye | number | 119 | 50.9 | 6 | 1.7 | 4 | 1.2 | 129 | 37.0 |
| | weight | 163.2 | 58.0 | 2.4 | 0.7 | 6.7 | 2.0 | 172.3 | |
| Yellow perch | number | 30 | 12.8 | 0 | - | 1 | 0.3 | 31 | 8.9 |
| | weight | 12.2 | 4.3 | - | - | - | - | 12.2[2] | |
| Total | number | 234 | 67.1 | 59 | 16.9 | 56 | 16.0 | 349 | |

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1. Weights of suckers and perch not available for Swift Current Reservoir and Swift Current Creek.

2. Duncairn Reservoir only.

Table 26: Fishing effort and catch per unit effort in 3 locations on the Swift Current Creek System in 1988.

| Site | No. Net Sets | No. Fish | Catch/unit effort |
|---|---|---|---|
| Duncairn Reservoir | 6 | 234 | 39 |
| Swift Current Reservoir | 1 | 59 | 59 |
| Swift Current Creek | 1 | 56 | 56 |
| Total | 8 | 349 | 43.6 |

#### 4.2.2.2.1 Walleye

A total of 129 walleye was taken in gillnets in the 3 sites on the Swift Current Creek system in 1988. Duncairn Reservoir yielded 92% of this catch with only 6 and 4 fish being caught in Swift Current Reservoir and Swift Current Creek, respectively (Table 25).

The length-frequency distribution of walleye from Duncairn Reservoir is shown in Fig. 62. Sizes ranged from 17.5 cm to 64.2 cm in fork length, with the majority of fish being in the 38 cm to 48 cm range. Walleye were caught in all mesh sizes of gillnet (Fig. 62) but appeared to be most vulnerable to the 7.6 cm and 10.2 cm sizes. Average fork length was determined to be 45.7 cm and average weight was 1371.3 g (Table 27). The resulting length-weight relationship, shown in Fig. 63, is illustrated by the equation

$$W=0.0062L^{3.0831}$$

where W is weight in grams and L is fork length in centimetres.

Coefficients of condition were calculated for walleye taken from all 3 sampling sites (Table 28). Walleye from Duncairn Reservoir had a higher condition factor (K=1.26) than those from Swift Current Reservoir (K=1.06) or Swift Current Creek (K=1.08).

A total of 119 stomachs from walleye caught in Duncairn Reservoir was examined for food remains. Fish, including longnose dace, walleye, and unidentified minnows, comprised 35% of the volume in the 37 stomachs containing food (Table 29). Freshwater shrimp had the next highest occurrence (34%) and midge larvae made up 24%. Additional food items included water boatmen, dragonfly nymphs and caddisfly larvae.

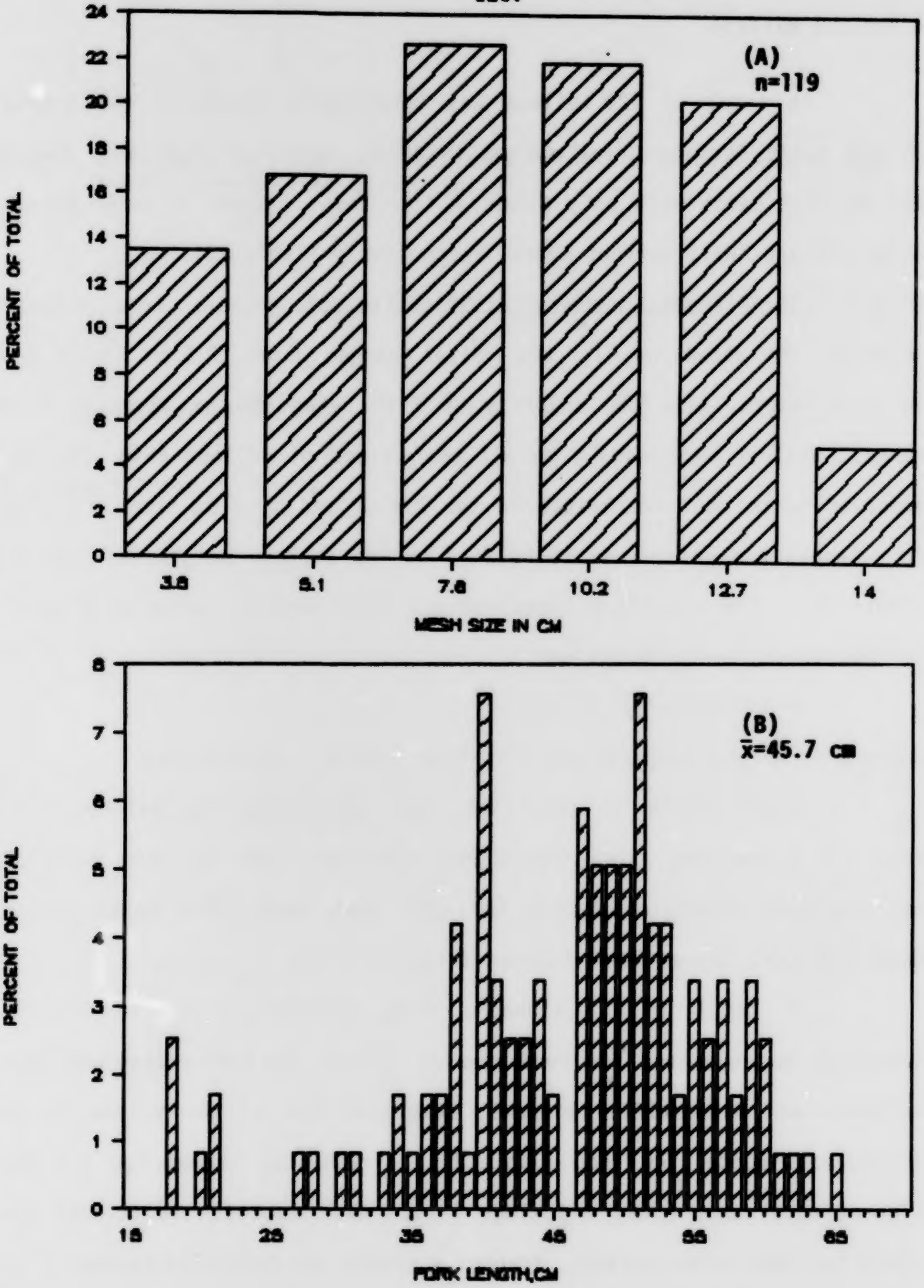

Fig. 62. Distribution of catch in various mesh sizes (A) and length-frequency distribution (B) of walleye caught in gillnets in Duncairn Reservoir in 1988. (n=number of fish; $\bar{x}$=mean fork length).

Table 27: Summary of length/weight data for fish caught in gillnets in 3 sampling sites on the Swift Current Creek System in 1988.

| Species | Length (cm) | | | Weight (g) | | |
|---|---|---|---|---|---|---|
| | Average | Maximum | Minimum | Average | Maximum | Minimum |
| DUNCAIRN RESERVOIR | | | | | | |
| Common white sucker | 37.6 | 52.0 | 8.3 | 972.8 | 2150 | 75 |
| Northern pike | 60.3 | 98.5 | 30.0 | 2096.0 | 7450 | 200 |
| Shorthead redhorse | 38.7 | 49.2 | 35.5 | 1072.3 | 2150 | 675 |
| Walleye | 45.7 | 64.2 | 17.5 | 1371.3 | 3350 | 60 |
| Yellow perch | 26.4 | 31.9 | 13.8 | 405.8 | 675 | 35 |
| SWIFT CURRENT RESERVOIR | | | | | | |
| Northern pike | 40.3 | 75.0 | 24.0 | 508.3 | 2270 | 90 |
| Walleye | 33.1 | 34.0 | 32.6 | 391.6 | 400 | 375 |
| SWIFT CURRENT CREEK | | | | | | |
| Northern pike | 67.1 | 90.4 | 38.5 | 3405.4 | 7000 | 454 |
| Walleye | 53.1 | 57.3 | 45.7 | 1681.2 | 2250 | 1025 |
| SWIFT CURRENT CREEK SYSTEM | | | | | | |
| Common white sucker | 37.2 | 52.0 | 8.3 | 951.3 | 2150 | 75 |
| Northern pike | 54.1 | 98.5 | 24.0 | 1766.5 | 7450 | 90 |
| Shorthead redhorse | 38.7 | 49.2 | 35.5 | 1072.3 | 2150 | 675 |
| Walleye | 39.8 | 90.2 | 17.8 | 1080.5 | 5500 | 60 |
| Yellow perch | 26.4 | 31.9 | 13.8 | 4405.8 | 675 | 35 |

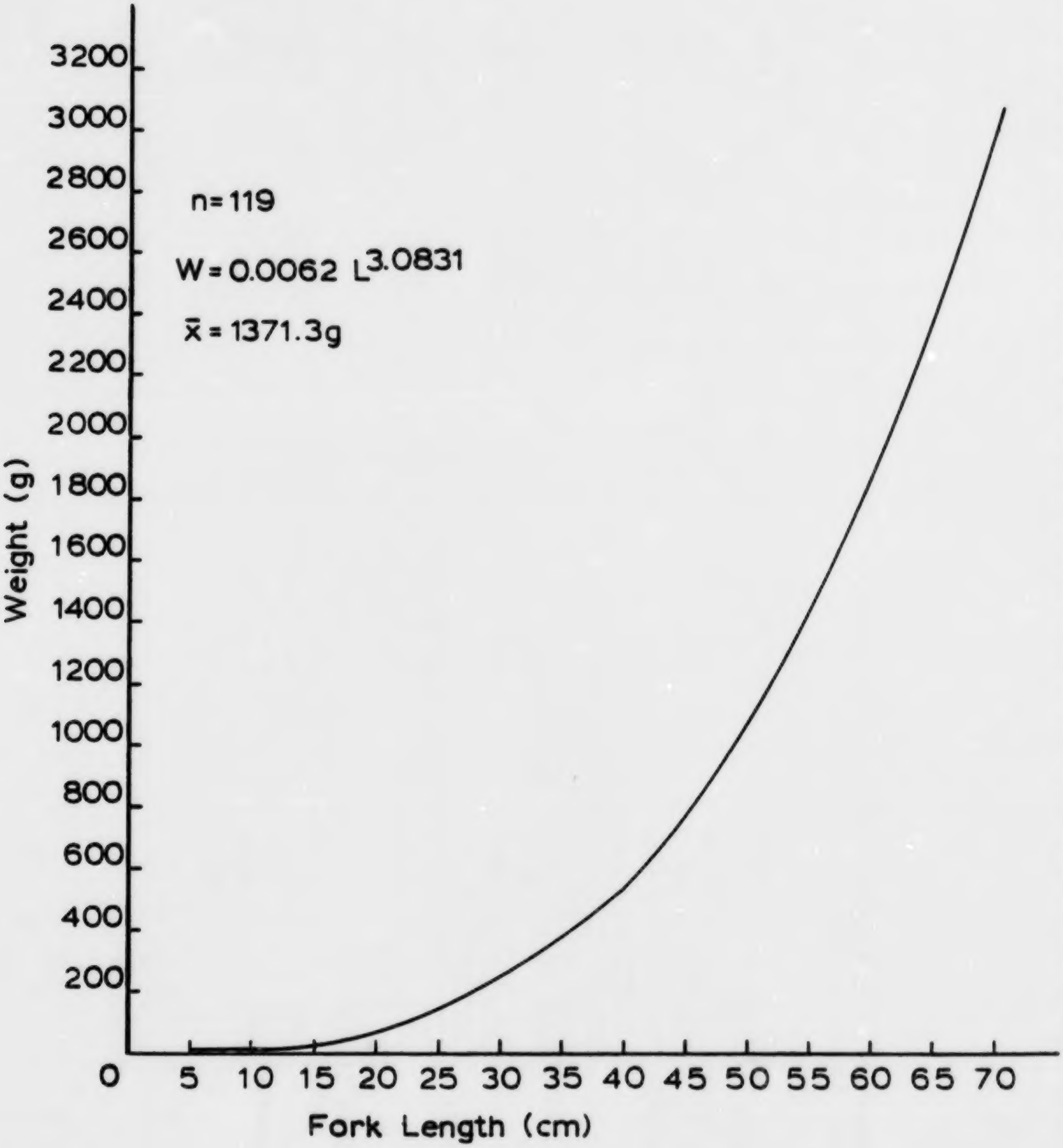

Fig. 63. Length-weight relationship of walleye caught in gillnets in Duncairn Reservoir in 1988. (n=number of fish; x̄=mean weight).

Table 28: Coefficients of condition (K) of 5 fish species caught in gillnets in 3 sampling locations on the Swift Current Creek System in 1988.

|  | Duncairn Reservoir |  |  | Swift Current Reservoir |  |  | Swift Current Creek |  |  |
|---|---|---|---|---|---|---|---|---|---|
| Species | No. | K | SD[1] | No. | K | SD | No. | K | SD |
| Common white sucker | 47 | 1.95 | ±0.10 | - | - | - | - | - | - |
| Northern pike | 19 | 0.73 | ±0.05 | 18 | 0.63 | ±0.06 | 10 | 0.85 | ±0.15 |
| Shorthead redhorse | 19 | 1.80 | ±0.12 | - | - | - | - | - | - |
| Walleye | 119 | 1.26 | ±0.15 | 5 | 1.06 | ±0.02 | 4 | 1.08 | ±0.07 |
| Yellow Perch | 30 | 1.90 | ±0.26 | - | - | - | - | - | - |

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1 - standard deviation

Table 29: Occurrences of food items in the stomachs of 3 fish species caught in gillnets in Duncairn Reservoir in 1988. (% composition by volume).

| | Walleye | Northern pike | Yellow perch |
|---|---|---|---|
| No. sampled | 119 | 19 | 30 |
| No. with food | 37 | 5 | 20 |
| Fish remains | 35 | - | - |
| Chironomidae | 24 | - | 6 |
| Corixidae | 1 | - | 79 |
| Odonata | 3 | 2 | 5 |
| Trichoptera | 1 | - | - |
| Amphipoda | 34 | 98 | 5 |
| Unidentifiable | 2 | - | - |

### 4.2.2.2.2 Northern Pike

Northern pike were taken in gillnets at all 3 sampling locations on the Swift Current Creek system in 1988. The total number of fish was 54 and made up 15.5% of the total catch (Table 25). In terms of numbers of pike, Swift Current Reservoir yielded the most (43%) but Duncairn Reservoir had the highest weight yield (47%).

Pike from Duncairn Reservoir were highly variable in size, ranging from 30.0 cm to 98.5 cm in fork length (Table 27). Swift Current Reservoir pike were slightly more restricted in their size range. The smallest fish taken from this site had a fork length of 24.0 cm; the largest was 75.0 cm. Average fork length of northern pike from Swift Current Reservoir was 40.3 cm. Duncairn Reservoir pike had an average fork length of 60.3 cm.

Insufficient data were collected to establish reliable length-weight curves for northern pike from any of the 3 sites.

Calculated coefficients of condition suggest that northern pike from Swift Current Creek were in better condition than those taken from the other two sites (Table 28). Pike from Swift Current Reservoir had the lowest condition factor.

Analysis of stomach contents collected from 19 Duncairn Reservoir pike shows that freshwater shrimp (Amphipoda) were the major food item. These organisms comprised 98% of the volumetric content in the 5 stomachs that contained food (Table 29). Dragonfly nymphs (Odonata) made up the remaining 2%.

#### 4.2.2.2.3 Yellow Perch

A total of 31 yellow perch were caught in gillnets in the Swift Current Creek system in 1988 (Table 25). One was taken from Swift Current Creek; the remainder were captured in Duncairn Reservoir.

The 7.6 cm mesh size was the most effective in catching yellow perch in Duncairn Reservoir (Fig. 64). The majority of fish were between 25 cm and 29 cm in fork length (Fig. 64) but sizes ranged from 13.8 cm to 31.9 cm with an average fork length of 26.4 cm (Table 27). Average weight was 405.8 g. The resulting length-weight relationship is described by the equation

$$W=0.0030L^{3.5567}$$

where W is weight in grams and L is fork length in centimetres. The length-weight curve is shown in Fig. 65.

The condition factor of yellow perch from Duncairn Reservoir was calculated at 1.90 (Table 28).

Food items most prevalent in 20 of the 30 yellow perch stomachs examined for food remains were water boatmen (Corixidae) (Table 29). Other food items included midge larvae (Chironomidae), dragonflies (Odonata) and freshwater shrimp (Amphipoda).

#### 4.2.2.2.4 Other Species

Common white suckers and shorthead redhorse were also caught in gillnets set in the Swift Current Creek system in 1988. The combined numbers of these fish made up approximately 39% of the total catch. Common white suckers were taken from all 3 sampling sites and were most numerous in Duncairn Reservoir (Table 25). Shorthead redhorse were captured only in Duncairn Reservoir and Swift Current Creek with approximately 56% of the catch being taken from the latter site.

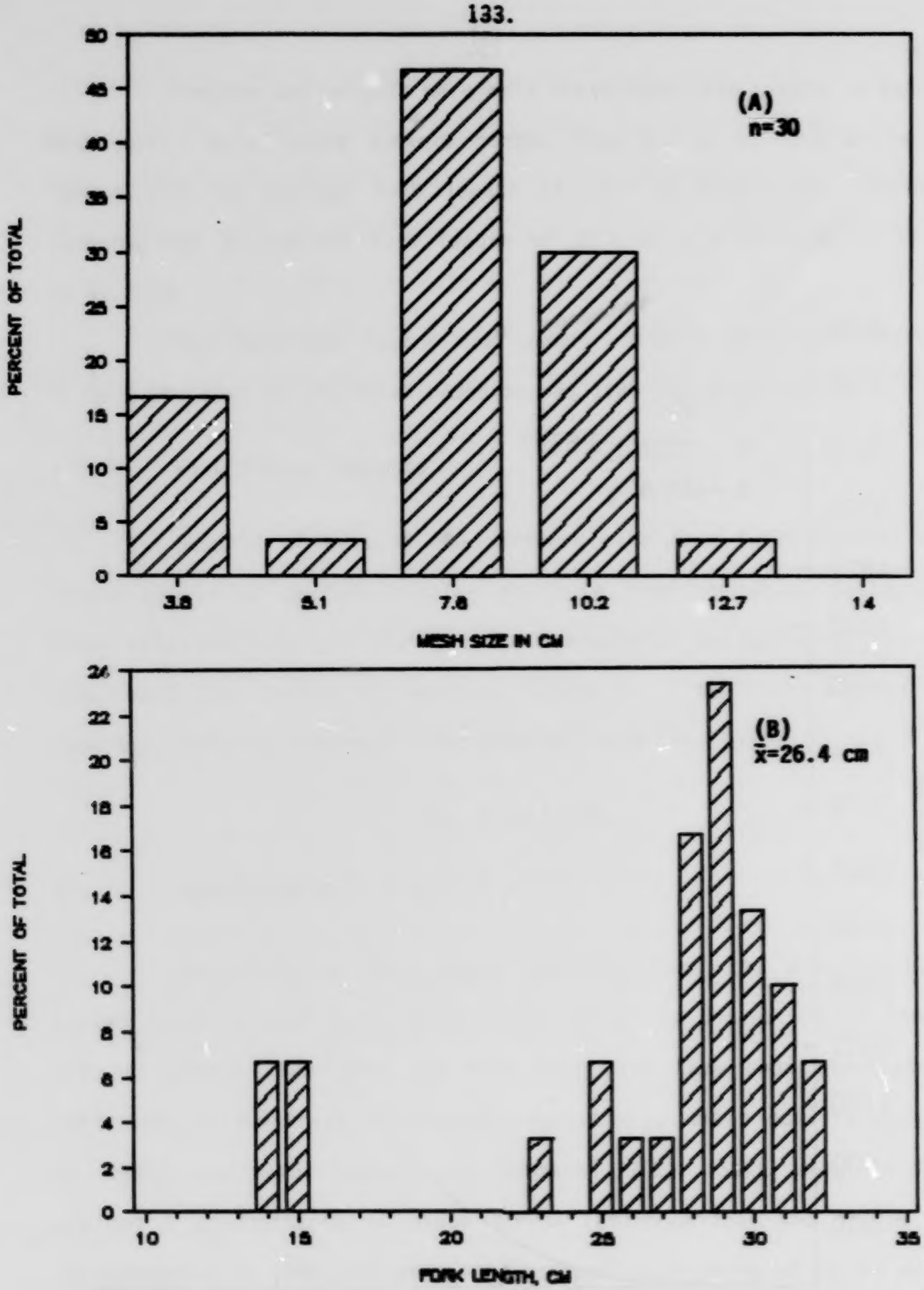

Fig. 64. Distribution of catch in various mesh sizes (A) and length-frequency distribution (B) of yellow perch caught in gillnets in Duncairn Reservoir in 1988. (n=number of fish; $\bar{x}$=mean fork length).

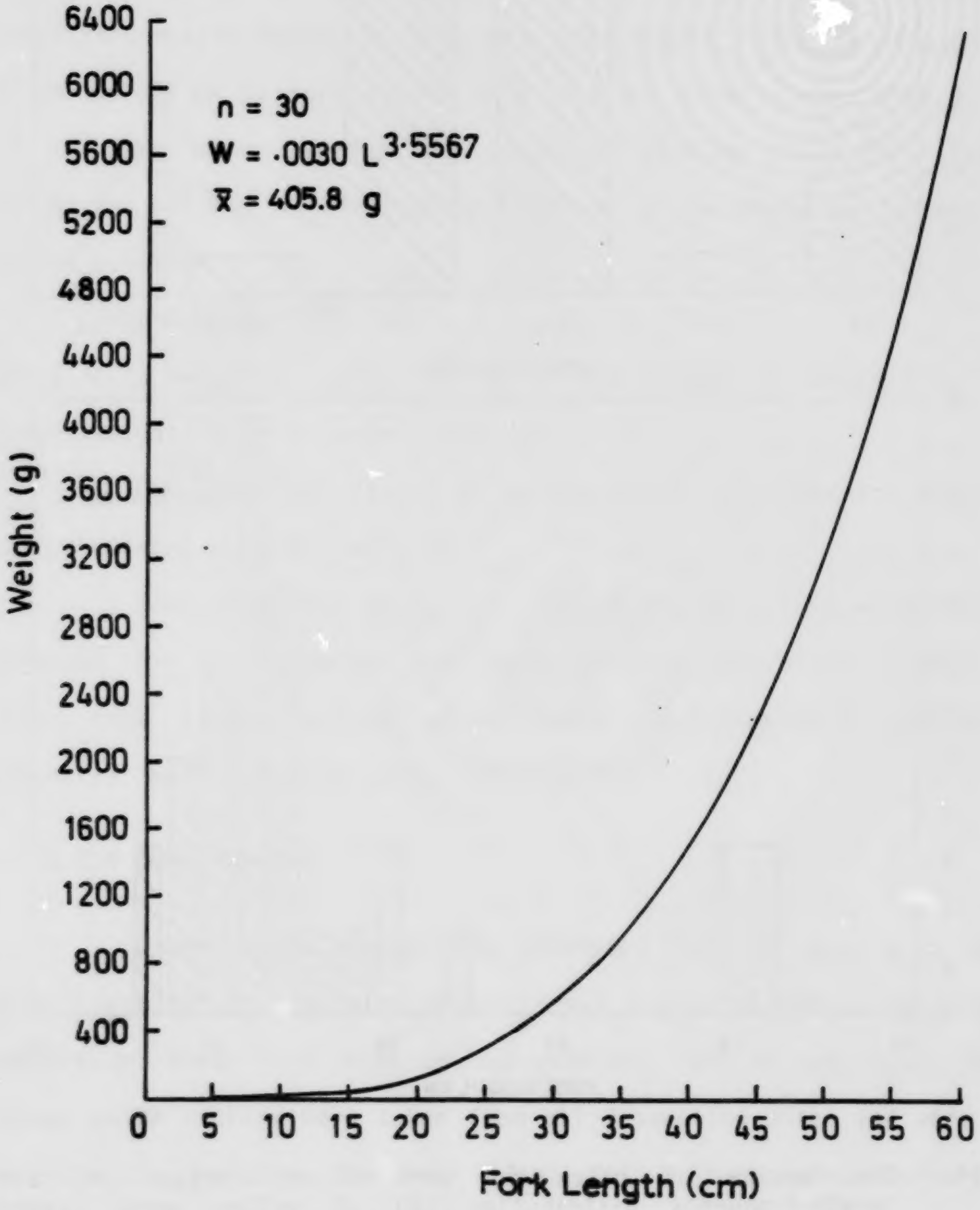

**Fig. 65.** Length-weight relationship of yellow perch caught in gillnets in Duncairn Reservoir in 1988. (n=number of fish; $\bar{x}$=mean weight).

Lengths and weights were only taken from fish caught in Duncairn Reservoir. Here, white suckers ranged from 8.3 cm to 52.0 cm in fork length with an average fork length of 37.6 cm (Table 27). Shorthead redhorse had an average fork length of 38.7 cm with a range of 35.5 cm to 49.2 cm.

The condition factor for common white suckers was determined to be 1.95; that of shorthead redhorse was 1.80 (Table 28).

### 4.2.3 Fish Tissue Analyses

Samples of walleye and northern pike from Swift Current Creek showed levels of mercury similar to those from the South Saskatchewan River at Estuary Ferry. Fish from both Broderick and Dellwood Reservoirs have very low levels of mercury (Table 13). No fish samples were submitted from the reservoirs for detailed metal analyses.

# 5. DISCUSSION

## 5.1 INVERTEBRATES

Results from this study indicate that the distribution of bottom fauna in the South Saskatchewan River is uneven. Such findings are not unique (Reed 1962 and Pipe 1982) and have been attributed to variances in substrate (including vegetation), water quality (Tones *et al.* 1980), and water temperature (Lehmkuhl 1972). Soft, oozy substrates yielded a predominance of midge larvae (Chironomidae) and sludge worms (Oligochaeta) in 1988, and were more productive in terms of kg dry $wt \cdot ha^{-1}$ than were rocky bottom areas which were inhabited by caddisflies (Trichoptera) and mayflies (Ephemeroptera). A similar distribution was reported by Reed (1962) and Pipe (1982), however, Reed (1962) found the rocky areas to be more productive than the soft substrate types.

Mayflies and caddisflies were found at all sampling locations except Gardiner Dam. According to Lehmkuhl (1972), modifications in the temperature regime of the South Saskatchewan River below the dam have had an impact on the diversity and numbers of insects, particularly mayflies. The dam stabilizes the water temperature, keeping it warm in winter and cool in summer. This effectively eliminates the critical temperature fluctuations required by many organisms for the successful completion of their life cycle. The area immediately below the dam is subject to major diurnal fluctuations in water levels ranging from 0.6 m during the summer to more than 1 m during peak power production during the winter (Appendix 9). Such fluctuations intermittently expose areas of shoreline habitat making it unsuitable for invertebrate species. The effect of these short-term fluctuations on shoreline habitat is diminished progressively downstream of the dam and is no longer visible at Saskatoon.

The South Saskatchewan River is relatively poor in terms of standing crop of benthic invertebrates, particularly when compared to Duncairn Reservoir on Swift Current Creek, the 6 reservoirs of the Saskatoon Southeast Water Supply System, and the 10 most productive lakes in Saskatchewan where standing biomass ranges from 51 $kg \cdot ha^{-1}$ to 99 $kg \cdot ha^{-1}$ (Durbin 1981). When compared to the <6 $kg \cdot ha^{-1}$ reported by Reed (1962) for the South Saskatchewan River in 1957 and 1958, the 16 $kg \cdot ha^{-1}$ found in this study indicates an increase in the standing crop of organisms.

Productivity, similar to the distribution of invertebrates, was not constant throughout the course of the river. Productivity increased in a downstream direction with samples from the Clarkboro and Fenton Ferry crossings being approximately 12 times greater than those taken at Estuary Ferry. A possible explanation for this may be found in the effects of spring run-off and sudden releases of water from Lake Diefenbaker. Although water levels were very low in 1988, even minor increases in flow could have had a scouring effect resulting in a displacement of benthic sediments and organisms (Anderson and Lehmkuhl 1968). O'Hop and Wallace (1983) reported that numbers of aquatic organisms drifting during storms and the amount of detritus in suspension resulting from erosion were significantly correlated. They also observed that loss from upstream populations, resulting from this drift, corresponded to a gain to populations in downstream area.

In addition to having the highest number of aquatic organisms in 1988, Clarkboro and Fenton Ferries also had a high incidence of algae and macrophyte growth. In 1957 and 1958, Clarkboro and Hague had from 3 to 5 times the amount of plankton at sampling stations upstream of Saskatoon (Reed 1959). Organic enrichment resulting from effluent from the Saskatoon sewage treatment plant has been identified as a causative agent, having an effect on algal growth in The South Saskatchewan River for up to 25 km downstream (Tones *et al.* 1980). Similar increases in algal biomass were observed below Lethbridge and Medicine Hat (Davies *et al.* 1977). The algae and macrophytes provide improved habitat for fauna, such as mayflies, caddisflies and midge larvae. Sludge worms and other burrowing forms thrive in deposits of organic sludge (Hawkes 1975) provided as a result of effluent discharge. These factors serve to explain the increased benthos production downstream of Saskatoon.

It has been observed in other studies (Royer *et al.* 1971, Pipe 1982, and Merkowsky 1987) that low oxygen concentrations, resulting from organic pollution, cause a decrease in the occurrence of 'oxygen loving' organisms, such as mayflies and caddisflies, and an increase in organisms capable of tolerating reduced oxygen levels (i.e. sludge worms). Our study failed to identify any change in species composition which would reflect decreased oxygen levels downstream of Saskatoon.

Newly created impoundments generally have small numbers of bottom fauna until the reservoir bottom stabilizes. Once stabilization occurs, populations of benthic organisms become established. In 1968, soon after the reservoirs were created, Blackstrap and Broderick reservoirs yielded a standing crop of 17.91 $kg{\cdot}ha^{-1}$ and 5.61 $kg{\cdot}ha^{-1}$, respectively (Royer 1970). In 1988, this yield was almost double in Blackstrap and almost 8 times greater in Broderick Reservoir. These results suggest that a rich benthic fauna has become established in response to nutrient rich local runoff and water pumped from Lake Diefenbaker.

## 5.2 FISH SPECIES

Twenty-seven species of fish were captured by gillnetting or seining in 1988. The diversity of species was much greater than the 19 collected in 1980 between the Muskoday Indian Reserve and the confluence with the North Saskatchewan River (Pipe 1982). All species except pearl dace (*Semotilus margarita*) and silver redhorse (*Moxostoma anisurum*) caught in 1980 were also caught in the present study. Of the 21 species found in 1957 and 1958 in the South Saskatchewan River and its tributaries (Reed 1962), silver redhorse, mountain sucker

(*Pantosteus jordanii*), and pearl dace were not collected in 1988. Spottail shiners were caught in seine hauls in this study and in the 1980 study (Pipe 1982) but were not encountered by Reed (1962). The combined contribution of spottail shiners, emerald shiners, and river shiners to the total seine net catch in 1988 (22.9%) was much larger than the 3.1% reported by Pipe (1982) for the same 3 species. Fathead minnows and flathead chubs were found in the seine net in 1988 and in 1957 and 1958 (Reed 1962) but were not encountered in the South Saskatchewan River in 1980 or 1976 (Pipe 1982). Species not reported by either Pipe (1982) or Reed (1962) include Iowa darter, mooneye, lake whitefish and cisco. Mooneye have been collected in the Saskatchewan River and South Saskatchewan at Saskatoon (Atton and Merkowsky 1983). The specimen taken at Estuary Ferry represents a westward range extension for this in Saskatchewan, although specimens have become common in the Red Deer River since construction of Gardiner Dam (W. Roberts, Pers. Com[1]). Whitefish and cisco were numerous in the tailwaters of Gardiner Dam and probably originated in Diefenbaker Lake. This was outside the study area discussed by Pipe (1982) and did not exist when Reed (1962) did his study. Iowa darters were captured in abundance at one site near Saskatoon.

One brook trout and one rainbow trout were captured in gillnets below Gardiner Dam. These two species were part of an experimental stocking program undertaken to introduce salmonids in the cold water below the dam by Sask. Parks, Recreation and Culture, Fisheries Branch in 1987 (brook trout) and 1988 (rainbow trout). One lake sturgeon was taken at Estuary Ferry. Fisheries Branch information indicates that while sturgeon were once found throughout the South Saskatchewan River, their distribution today appears to be restricted to an area near the confluence of the Red Deer River. Imposition of the Gardiner Dam and Lake Diefenbaker has eliminated potential spawning habitat and restricted migration of sturgeon in the river. These factors combined with angling pressure are probable causes in the perceived reduction of the sturgeon population downstream of Lake Diefenbaker.

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[1] W. Roberts, Curator, Museum of Zoology, University of Alberta, Edmonton.

Merkowsky (1987) reported a catch of 22.2 gamefish per standard gang of gillnet to represent a relatively low abundance in the North Saskatchewan River when compared to six other waterbodies in Saskatchewan. Gamefish included were walleye, pike, sauger and goldeye. Approximately 12 gamefish were caught per standard gang of gillnet in the South Saskatchewan River in 1988. This represents a very low abundance especially when compared to the Saskatoon Southeast Water Supply System (94.7 gamefish/set) and the Swift Current Creek System (91.5 gamefish/set). Due to forces of current, nets placed in a fluvial environment are generally set parallel to the shore and probably do not fish effectively (Reed 1962). Therefore the abundance of gamefish throughout the Saskatchewan River System may be more than the net results from these studies indicate.

Walleye were the most frequently encountered gamefish in the South Saskatchewan River in 1988 as opposed to the goldeye reported by Reed (1962) and Pipe (1982). Fewer walleye were captured in gillnets in the latter two studies than in the present one suggesting that walleye has become a more successful species over the years. These fish are also widespread as they were found at all sampling locations on the South Saskatchewan River. A large, successful walleye population in Lake Diefenbaker may be a source of stock for the river system.

The length-frequency distribution of walleye from the South Saskatchewan River suggests the presence of several age classes, and subsequently, good recruitment. Three age classes are indicated by the length-frequency distribution for the reservoirs with the exception of Dellwood. Here, only two distinct age classes are apparent, which reflects the past two years of fingerling walleye stocking in this reservoir.

Walleye from the South Saskatchewan River tended to be consistently heavier per unit of fork length than those from Duncairn Reservoir but were consistently lighter than those in the reservoirs of the Saskatoon Southeast Water Supply. This suggests that the river provides better habitat for walleye than does Duncairn Reservoir but poorer habitat than that provided by the other 6 reservoirs. The exception is Dellwood Reservoir. Here walleye were heavier per unit length up to 40 cm in fork length after which weight increments dropped off and the river walleye displayed a heavier weight per unit length. The number of walleye found in Dellwood Reservoir far exceeded the number found elsewhere due to the stocking effort. Consequently, competition for food and space may be a critical factor regulating the population in the reservoir. However, condition factors for walleye were not dissimilar among the 3 distinct sampling areas and are comparable to those reported by Pipe (1982) for walleye taken from the South Saskatchewan River in 1980.

As in Reed's (1962) findings, fish comprised the largest portion of the diet of walleye from the South Saskatchewan River in 1988. Durbin (1981) also found fish to be a preferred food item of lake walleye. However, midge larvae were the food item most readily identified in those fish taken from the reservoirs. This could be a reflection of abundance rather than preference although fathead minnows, which were numerous in Dellwood Reservoir, were not found in any of the walleye stomachs sampled from there.

Goldeye was found to be the second most abundant gamefish species in the South Saskatchewan River in 1988 but were not found in the reservoirs or the Swift Current Creek system. These fish were abundant throughout the river in 1957 and 1958 (Reed 1962). Current netting results indicate that while goldeye can still be found in most areas of the river, they are most prevalent around the Estuary Ferry area. These results are consistent with Roberts' (Pers. Com.) observations that goldeye populations have increased upstream of Lake Diefenbaker.

Throughout the sampling period, goldeye with ripe sexual products were captured suggesting that this species spawns during the summer period. Kennedy and Sprules (1967) suggested that goldeye spawning occurs over a period of 3-6 weeks during May or June. Donald and Kooyman (1977) found that most spawning occurs over a 5-7 day period and is essentially completed by the end of May in the Peace-Athabasca River System. Reed (1962) suggested that goldeye possibly move upstream in a spawning run which may account for the apparent success of goldeye upstream of Lake Diefenbaker. Obstructions such as the Gardiner Dam and the weir at Saskatoon may be interfering with the ability of goldeye to find suitable spawning sites thereby resulting in low numbers of this species in the lower reaches of the river. Furthermore Roberts (Pers. Com.) notes that goldeye spawning activity in the Red Deer River appears to be triggered by increasing flow rates in June and that a high correlation occurs between water level and upstream migrations. Modified stream flows downstream of Gardiner Dam may be inappropriate to trigger migration and spawning activity resulting in reduction of goldeye in this reach of the River. Pipe (1982) reported an abundance of goldeye in the South Saskatchewan River just above the confluence with the North Saskatchewan River. Probably, then, this area and the area around Estuary Ferry provide the most suitable locations for this species in the South Saskatchewan River.

The maximum fork length of goldeye captured in 1988 is approximately equal to that reported by Pipe (1982) for goldeye caught in 1980. Although fish taken in the present study tended to weigh more per unit length than those measured in the earlier study, coefficients of condition were similar. The bimodal length-frequency distribution of this species is indicative of two distinct age classes.

Although goldeye are reportedly opportunistic feeders (Scott and Crossman 1973), the diet of goldeye captured in 1988 was almost exclusively made up of insects, particularly water beetles. Similar results with regard to the diet of this species were reported by Pipe (1982).

Northern pike were taken from all sampling locations in 1988, indicating a widespread distribution. They were most abundant in the Swift Current Creek system. The South Saskatchewan River yielded the fewest pike but more than reported in earlier studies (Reed 1962 and

Pipe 1982). The pike appears to have become a more successful species in the South Saskatchewan River over the past three decades in contrast to the pike populations in the North Saskatchewan River which have decreased relative to other species over the same time period (Merkowsky 1987). This may be the result of more extensive weed growth caused by clear water below Gardiner Dam, and nutrient enrichment from the City of Saskatoon domestic sewage effluent. On the other hand low spring water flows result in a scarcity of shallow vegetated areas suitable for pike spawning and would, therefore, tend to limit pike production rather than enhance it.

The maximum fork length of northern pike captured in 1988 was 90.2 cm in the South Saskatchewan River, 92.8 cm in the Saskatoon Southeast Water Supply System and 98.5 cm in Swift Current Creek System. The average length of the 14 fish taken in 1980 was 47.4 cm (Pipe 1982) which is similar to the average lengths of those pike caught in the South Saskatchewan River and the Saskatoon Southeast Water Supply System in the current study. All of these fish tended to be smaller than those captured in the Swift Current Creek System.

Coefficients of condition of northern pike were generally lower than those of the other species but were similar among the 3 sampling locations. With the exception of fish taken from Bradwell Reservoir and Gardiner Dam, condition factors of fish taken from the South Saskatchewan River in 1988 were slightly lower than that of pike captured in the North Saskatchewan River in 1985 and 1986 (Merkowsky 1987).

Results of stomach analyses for this species show substantial spatial variance. The major food item of pike from the South Saskatchewan River was crayfish. In contrast, pike from the Saskatoon Southeast Water supply fed primarily on fish. In the Swift Current Creek System, freshwater shrimp were the largest dietary constituent. Pike are opportunistic feeders, foraging upon whatever is available (Scott and Crossman 1973). These variable diets, therefore, reflect a variability in the abundance of major food items.

Sauger, a close relative of walleye, was encountered only in the South Saskatchewan River in 1988. This species was poorly represented in the gillnet catch both in this study and in that conducted by Reed (1962) in 1957 and 1958. However, in 1980, sauger were relatively numerous in the reaches of the South Saskatchewan River below Muskoday Indian Reserve (Pipe 1982). According to Scott and Crossman (1973) large turbid slow-flowing rivers are the preferred habitat of sauger. Therefore, the lower reaches of the South Saskatchewan River probably provide more suitable habitat for this species than do the less turbid upper reaches below Lake Diefenbaker. The portion of the river upstream of Lake Diefenbaker provided the best habitat for sauger in this study.

Due to the small number of sauger captured, reliable length-weight curves for this species could not be established. But, condition factors for sauger captured in this study are consistent with those reported by Pipe (1982).

Sauger have a diet similar to that of walleye, feeding primarily on fish. In 1988, their diet appeared to be exclusively fish but 80% of the stomachs were empty. Pipe (1982) reported similar observations and concluded that the contents had been regurgitated; a phenomenon known to occur in sauger and walleye when they become entangled in a gillnet (Reed 1962).

Lake whitefish have a restricted distribution in the South Saskatchewan River; all but one specimen were collected from the Gardiner Dam sampling site and probably originated in Lake Diefenbaker. In contrast, this species was relatively abundant in the Saskatoon Southeast Water Supply System. Since no whitefish were stocked in these reservoirs they will have originated in Lake Diefenbaker and adapted to the static conditions provided by the reservoirs.

The bimodal length-frequency distribution of lake whitefish from the South Saskatchewan River is indicative of two age classes, suggesting that natural recruitment may occur in the riverine environment. In the reservoirs of the Saskatoon Southeast Water Supply System, three age classes were generally represented by a trimodal distribution.

Lake whitefish from the river tended to be smaller in fork length and consistently lighter than those from the reservoirs. This is reflected in a substantially lower condition factor for this species in the river. Because lake whitefish are generally a lake dwelling fish (Scott and Crossman 1973), it is not surprising that the reservoirs would appear to provide more suitable habitat than the river. However, the river whitefish favourably compare to whitefish from other waterbodies in Saskatchewan. The length-weight relationship for whitefish taken from Dore Lake in 1986 (Sawchyn 1987a) is not unlike that for the same species collected from the South Saskatchewan River in 1988. Mean lengths and weights of fish taken from Pinehouse Lake in 1986 (Liaw 1988) were lower than those reported in the present study although maximum lengths and weights were similar in both studies. This suggests that the reservoirs of the Saskatoon Southeast Water Supply System provide optimal habitat for the growth and survival of the lake whitefish.

Members of this species are bottom feeders, foraging upon a wide variety of benthic organisms (Scott and Crossman 1973). Fish from the river appeared to be feeding primarily upon plankton and midge larvae. In the reservoirs, snails were a major food item. Other studies have reported fingernail clams to be of major dietary significance to lake whitefish (Liaw 1988 and Sawchyn 1987b), however in this study, these organisms were infrequently encountered.

Burbot, similar to the lake whitefish, had a distribution restricted to an area of the South Saskatchewan River just below Gardiner Dam in 1988. Reed (1962) suggested that burbot were widely distributed in the South Saskatchewan River in 1957 and 1958. An additional specimen was collected farther downstream at Fenton Ferry in 1988 and two fish were captured below the Muskoday Indian Reserve in 1980 (Pipe 1982) indicating that a wider distribution is probable. Burbot in a river situation remain relatively stationary in the current and are not as vulnerable to gillnets as other more active species.

The length-frequency distribution of this species could be indicative of multiple age classes but probably reflects, moreso, the growth differential common between males and females of this species (Scott and Crossman 1973). The absence of small fish in the gillnet should not be interpreted to suggest little or no recruitment of burbot in the river. Young burbot are normally found among rocks and debris and do not lend themselves to seining or gillnetting. Although they have been known to move into rivers to spawn, burbot generally spawn in the deeper waters of a lake (Scott and Crossman 1973).

The condition coefficient of burbot was the lowest of all the species captured in the South Saskatchewan River in 1988. The length-weight relationship indicates that these fish had a longer fork length per unit weight than did other species encountered.

Burbot appeared to feed exclusively upon fish although younger smaller members of the species will consume insects and other invertebrates (Scott and Crossman 1973). Voracious in their feeding habits, some burbot were captured in the smaller meshes of gillnet while obviously preying upon smaller, already entangled ciscoes.

Ciscoes were another species of fish with a distribution restricted to the Gardiner Dam area of the South Saskatchewan River. This may have been the result of cooler prevailing water temperatures at that location. Neither Pipe (1982) or Reed (1962) reported the presence of this species in their respective studies.

The single peak in the length-frequency distribution of ciscoes suggests a single year class. One larger fish and one smaller fish were taken however, indicating that, while they may not have been numerous, older and younger fish were present.

Ciscoes are not generally recognized as having commercial or recreational value of their own. They do have an important role however, as a forage fish for other species considered economically significant. These species include burbot and lake trout (Sawchyn 1987b) and to a lesser extent, northern pike.

Yellow perch were not abundant in the South Saskatchewan River in 1988, nor have they been historically (Reed 1962). The majority of this species was captured in Bradwell Reservoir in the Saskatoon Southeast Water Supply System and in Duncairn Reservoir on Swift Current

Creek. The length-frequency distributions for these fish suggest there are two age classes of perch in Duncairn Reservoir and three age classes in Bradwell Reservoir.

Yellow perch in Duncairn Reservoir tended to be consistently heavier per unit of fork length than those in Bradwell Reservoir. In addition, the condition factor was substantially higher. This suggests that a more suitable habitat for yellow perch in provided by Duncairn Reservoir. No yellow perch were caught in Blackstrap Reservoir in this study. They are occasionally caught by anglers and appear in stomach contents of fish to confirm that a small population does exist. Similarly, netting results indicate very small perch populations in Dellwood and Zelma Reservoirs. The reason for their lack of success in these three reservoirs is unknown.

Perch displayed variability in the selection of food items. In the Saskatoon Southeast Water Supply System, however, midge larvae made up the bulk of the diet. In Duncairn Reservoir, where midge larvae were abundant, the less abundant water boatmen were the primary dietary constituent. No water boatmen were found in the other reservoirs at the time of sampling which suggests that when both midge larvae and water boatmen are present, the latter is a preferred food item.

Suckers were the most frequently encountered nongame fishes in the gillnets in 1988, particularly the common white suckers. In 1957 and 1958, shorthead redhorse and longnose sucker were each more abundant in the South Saskatchewan River than was the common white sucker (Reed 1962). Pipe (1982) reported similar findings for the lower reaches of the river in 1980. The results from the current study suggest that the white sucker has become a more successful species over the years.

Conversely, the shorthead redhorse and longnose sucker populations have decreased. A similar observation was made with regard to these two species in the North Saskatchewan River and it was suggested that competition from and predation by the increasingly successful walleye may have an affect on sucker abundance (Merkowsky 1987).

The shorthead redhorse had a consistently higher weight per unit length than did the other two sucker species. The longnose sucker had the lightest. These results concur with those reported by Pipe (1982) and are reflected in their respective coefficients of condition. This suggests that the South Saskatchewan River provides habitat most suited to the shorthead redhorse and least suited to the longnose sucker.

## 5.3 FISH TISSUE ANALYSES

The presence of mercury in fish in the South Saskatchewan River System was first recognized in 1969 when average levels of 9.1, 4.9 and 4.2 $mg \cdot kg^{-1}$ were reported in northern pike, walleye and goldeye, respectively at Clarkboro Ferry (Wobeser *et al.* 1970). Although mercury occurs naturally in low concentrations in most soils, the prime source of the high levels in the South Saskatchewan River has been associated with the discharges from a chlor-alkali plant located in Saskatoon. In addition mercury was used as a seed treatment to control fungus throughout the province. Direct discharges of mercury from these sources have been eliminated, (Waite and Harrison, 1988).

Mercury in fish in the South Saskatchewan River System has been monitored on a regular basis since the problem was first identified.

The results of the monitoring program have been recently summarized by Harrison and Waite (1988) who note that levels in sediments are diminishing and no longer pose a serious problem, however mercury levels in South Saskatchewan River fish have not substantially declined.

In recognition of the tendency of mercury to bioaccumulate in flesh and become a health risk to humans, the federal Department of Health and Welfare established a tolerance level of 0.5 $mg \cdot kg^{-1}$ mercury in food in Canada in 1971, recommending that fish with levels higher than 0.5 $mg.kg^{-1}$ not be eaten (SPRC 1988). This guideline was relaxed in 1984 to allow limited consumption of fish with mercury levels between 0.5 and 1.0 $mg.kg^{-1}$. In 1986 the guidelines were further modified to accommodate new medical information and recommendations of the World Health Organization based on studies of mercury poisoning in other countries. Present guidelines are as follows:

> "Fish with mercury concentrations of 0.5-1.5 $mg.kg^{-1}$ may be eaten in limited amounts. There are now two categories for limited consumption: 0.5-1.0 $mg.kg^{-1}$ and 1.0-1.5 $mg.kg^{-1}$. Recommended consumption for these categories differs, and is based on the amount of fish consumed over a given unit of time. No one should eat fish with mercury concentrations of more than 1.5 $mg.kg^{-1}$. Children and pregnant women should not eat fish containing mercury in excess of 0.5 $mg.kg^{-1}$ (SPRC 1988)."

References should be made to the "Mercury in Fish Guidelines for Consumption 1988" (SPRC 1988) for specific consumption recommendations.

Based on the above consumption guidelines, fish taken downstream of Saskatoon should be consumed in limited amounts.

Mercury levels in fish are known to become elevated in new reservoirs shortly after flooding (Harrison and Waite 1988) but stabilize at lower levels as the reservoir matures, generally within ten years. In consideration of these observations monitoring of mercury levels in fish should be undertaken as part of a program involving creation of new reservoirs, channel modification or flooding.

Preliminary scanning of fish for selected heavy metals was intended to identify those elements which may become toxic to aquatic fauna. Zinc was the only element in addition to mercury which appears to be related to any activities within the river basin and probably reflects levels of zinc in the soils of the drainage basin. The implications of the apparently high levels of zinc were not investigated.

## 5.4 FISH HABITAT

### 5.4.1 General

The distribution and relative abundance of various species of fish in the South Saskatchewan River and its tributaries is a direct reflection of the physical characteristics of their habitat. The study area may be divided as follows:

1) Alberta border to Lake Diefenbaker

   This portion of the river is characteristic of the waterway in its unmodified state. Typically the water is warm, silt laden, with seasonally widely fluctuating uncontrolled velocities. This habitat is ideally suited for goldeye, sauger, walleye, lake sturgeon and suckers; less suitable for northern pike and not suitable for lake whitefish, ciscoes, perch and salmonids.

2) Lake Diefenbaker

A large reservoir with all the characteristics of a large lake including clean water, summer thermal stratification. This habitat is most suitable for walleye, lake whitefish, ciscoes and northern pike. Lake trout will survive but are unable to spawn successfully because of exposure of eggs during winter drawdown.

3) Gardiner Dam

The area immediately downstream of Lake Diefenbaker provides the greatest diversity of fish species in the river primarily as a melting pot for species from diverse habitats. The cold hypolimnetic discharge provides cool clean water for salmonids such as rainbow and brook trout. Lake whitefish and ciscoes which escape from Lake Diefenbaker survive here even though they are not typical river species. The habitat is ideal for walleye but less suitable for pike.

4) Gardiner Dam to Saskatoon

This reach of the river is an area which is recovering from the effects of the reservoir with respect to temperature and turbidity but whose flow is stabilized by the operations of the hydroelectric plant. The fish population is sparse with respect to diversity and abundance. Quantities of invertebrate food organisms appear to be minimal. Species such as goldeye and sturgeon which migrate extensively appear to be largely excluded from this area. Weedy habitat suitable for pike is limited. The species best adapted to this habitat would be walleye.

5) Saskatoon to Clarkboro Ferry

This portion of the river thrives from the effects of nutrient enrichment from the City of Saskatoon. Rich organic deposits provide an ideal base for the largest diversity of invertebrate fauna and weed growth in the river system. These provide ideal conditions for suckers, northern pike and walleye.

6) Clarkboro Ferry to the Confluence

This zone is characteristically a recovery area from the effects of municipal and industrial waste discharge. In addition to pike and walleye, the downstream areas provide conditions more suitable for sauger and goldeye. Invertebrate species characteristic of undisturbed environments such as mayflies and caddisflies were most abundant at Fenton Ferry.

7) Small Reservoirs

The Saskatoon Southeast Water Supply System and Swift Current Creek provided an opportunity to develop several small eutrophic reservoirs ideal for the production of yellow perch, walleye and northern pike. No walleye spawning habitat exists in these reservoirs requiring them to be stocked at regular intervals. Whitefish have managed to become established from stock originating in Lake Diefenbaker although this habitat would not be considered typical for this species. Conditions are not suitable for a wide diversity of forage species.

### 5.4.2 Spawning Habitat

The low water levels in the South Saskatchewan River and lack of spring runoff in the tributaries in 1988 made it difficult to accurately assess the spawning habitat available to fish. Numerous areas that normally contain water, particularly in the spring, were dry in May of this year (i.e. streams around the Swift Current Creek area). As a result, many typical gravel and weed spawning beds of walleye and pike were either exposed or inaccessible. Unusually warm water temperatures early in 1988 may have initiated spawning and facilitated hatching in the river before the study began, but data collected on the spawning condition of fish captured in gillnets suggest that insufficient water in the traditional spawning sites may have resulted in a decreased spawning effort by river dwelling species.

Some cobble areas in swift flowing water and along the shoreline of the South Saskatchewan River were identified as potential spawning areas for species such as walleye, sauger, and suckers, during normal flow years. Walleye have also been known to spawn over sand, firm mud, or mats of vegetation (Johnson 1961), all of which are in abundance in the South Saskatchewan River.

Preferred spawning sites of northern pike are shallow uniform areas of submerged vegetation (Koshinsky 1979) often created by heavily vegetated flood plain areas during spring run-off. No such sites were evident in 1988, however, Pipe (1982) suggested that since the ice in the South Saskatchewan River melts rather than breaks up in the current, pike may move into suitable areas and spawn at breakup. This may have occurred this year but it was difficult to ascertain where the spawning beds would have been.

Goldeye generally spawn in shallow, backwater areas that have a firm substrate (Scott and Crossman 1973). Two such sites were identified along the south shore of the South Saskatchewan River between the confluence of the Red Deer River and Estuary Ferry. Evidence of any spawning activity, however, was not apparent.

The success of spawning in shoreline areas depends upon water levels. In 1988, the production from these areas probably was reduced substantially as a result of a quickly receding water line.

### 5.4.3 Rearing Habitat

The presence of fry and fingerlings in seine nets was indicative of some successful spawning in the South Saskatchewan River in 1988. Walleye and pike fingerlings were found in variable habitats, suggesting that these species are adaptable and will utilize what is available as long as food and cover are present. Both these species are piscivorous and were generally found in the presence of shiners, dace and sucker fingerlings. While invertebrates comprise a substantial portion of their diet in the first few weeks of life (Scott and Crossman 1973) fish remains have been found in stomachs from walleye 5 cm in length (Rawson 1957). Pike begin feeding upon fish at a similarly young age (Koshinsky 1979).

## 5.5 FISH AND DROUGHT

Over the past 10 years, Saskatchewan has been experiencing a drying trend. During such periods, water levels in streams, rivers and lakes tend to decrease dramatically due to lack of replenishment, and evaporation. The effects on agriculture and visible aquatic wildlife species such as muskrats and waterfowl are readily apparent. The effects on fish populations, however, are less obvious.

As already mentioned, streams void of water result in decreased availability of spawning areas which in turn may result in a failure to spawn. Exposure of spawning beds after spawning has occurred results in desiccation of eggs. In some cases, fish may become trapped in their spawning areas as channels to these sites become dry.

Shallow areas normally inhabited by fry and fingerlings become dry or reduced in size, forcing these small fish into areas less favourable for growth and subjecting them to a greater risk of predation from larger fish (Larkin 1956). Similarly, reduced areas of deep water for adult fish results in crowding. Competition for available space forces the weaker and less dominant individuals into shallower areas where there is little cover and the fish become exposed to a higher risk of predation from birds and fish eating mammals (Larkin 1956).

As water levels drop, water temperature increases. In addition, the substrate is exposed to sunlight facilitating growth of aquatic plants. Plants, through the process of respiration, require oxygen but as water temperature increases, there is a corresponding decrease in the dissolved oxygen content (Piper *et al.* 1982). Competition for oxygen between fish and plants may not be as important in a fluvial environment (Winger 1981) as in some pond situations under normal conditions. It may become important, however, during periods of severely reduced flows when fish become stranded in backwater pools or shallow bays. When flows are decreased, surface area contact with the atmosphere is reduced, thus reducing the amount of oxygen uptake (Hynes 1970). Stress to fish resulting from warm water temperatures and low oxygen levels may result in reduced feeding and growth rate, increased susceptibility to disease and parasites (Piper *et al.* 1982), and lowered survival (Chapman 1966) in fish.

### 5.6 UTILIZATION OF THE FISHERY RESOURCE

During the course of the study in 1988, several people were observed fishing at various sites in the study area, particularly in the reservoirs of the Saskatoon Southeast Water Supply System. Local residents reported walleye to be the most popular gamefish followed by northern pike, goldeye and whitefish. Sturgeon were reportedly highly sought after in the South Saskatchewan River near the Alberta/Saskatchewan border. The time allotted to complete the fieldwork, however, did not provide sufficient time to conduct an in depth survey on the utilization of the fishery resource on the South Saskatchewan River System.

## 6. CONCLUSIONS AND RECOMMENDATIONS

### 6.1 CONCLUSIONS

1. A biological investigation of the fishery was carried out on the South Saskatchewan River, including the Saskatoon Southeast Water Supply System and the Swift Current Creek System from May 01 to August 31, 1988.
2. Average standing crop of bottom fauna was determined to be 16.22 $kg.ha^{-1}$ in the main stem of the river, 30.98 - 211.85 $kg.ha^{-1}$ in the Saskatoon Southeast Water Supply System, and 182.65 $kg.ha^{-1}$ in the Swift Current Creek System. Midge larvae and sludge worms were the most numerous bottom fauna collected.

3. Twenty-seven species of fish were collected by gillnetting or seining in the South Saskatchewan River and adjoining systems. An average of 12 fish/net set were caught in the main stem of the river, 59.7 fish/net set were caught in the Saskatoon Southeast Water Supply System, and 43.6 fish/net set were caught in the Swift Current Creek System.
4. Common white suckers, lake whitefish and longnose suckers were the most numerous species in the river. Other species, in order of abundance, included walleye, shorthead redhorse, cisco, goldeye, northern pike, sauger, flathead chub, and quillback. Small fish species captured by seining included 3 species of shiner, brook stickleback, spoonhead sculpin, Iowa darter, trout-perch, fathead minnow, and longnose dace.
5. Common white suckers, walleye and lake whitefish were the most abundant species in the Saskatoon Southeast Water Supply System. Yellow perch was the fourth most abundant species followed by northern pike, and shorthead redhorse. Small fish species captured by seining included fathead minnows and brook sticklebacks.
6. The common white sucker, walleye, and northern pike were the most numerous species in the Swift Current Creek System. Shorthead redhorse and yellow perch were also present. Brook sticklebacks and longnose dace were collected in the seine net.
7. Mercury levels in fish downstream of Saskatoon are in the range where consumption guidelines should be applied. Levels upstream of Saskatoon and in the reservoir systems investigated are within the range for normal consumption. Zinc was the only other element found in significant amounts in fish tissues. Mercury levels in river fish appear to be gradually declining.

8. Potential spawning areas for walleye, sauger, and suckers were available throughout the river. Goldeye spawning sites were limited to the upper reaches of the river. No potential spawning areas for northern pike were identified.
9. Rearing areas and adult holding habitat were available throughout the course of the river.

## 6.2 RECOMMENDATIONS

1. An indepth examination of the utilization of the fishery resource in the South Saskatchewan River should be undertaken, complete with a creel census, interviews and questionnaires.
2. Sturgeon populations should be evaluated in more detail in the South Saskatchewan River. Only one specimen was collected in 1988 and no evidence was gathered on requirements for sturgeon reproduction.
3. Modification of river use patterns should place priority on implications to spawning success and habitat alteration of common fish species of economic significance including walleye, northern pike, goldeye, lake whitefish and sturgeon.
4. Monitoring of mercury levels in fish of the South Saskatchewan River basin should be continued, especially downstream from Saskatoon.

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# 8.0 APPENDICES

Appendix 1: Flow conditions during 1988 Fisheries Habitat Sampling Program.

| Sample Site | Location (Tp-Rg-M) | Sample Dates | Estimated Discharge* $(m^3.sec^{-1})$ | Water Level (m) | Average Channel Velocity $(m.sec^{-1})$ |
|---|---|---|---|---|---|
| Estuary Ferry | 23-28-W3 | May 9 - 10 | 53.0 | 450.6 | 1.2 |
| | | June 6 - 8 | 109.0 | | |
| | | June 27 - 29 | 153.0 | | |
| | | July 25 - 27 | 98.0 | | |
| D/S Gardiner Dam** | 27-7-W3 | May 11 - 13 | 57.0 | 498.2 | 0.3 |
| | | June 8 - 10 | 44.0 | 498.0 | 0.2 |
| | | July 5 - 7 | 47.0 | 498.1 | 0.3 |
| | | July 28 - 29 | 45.0 | 498.1 | 0.2 |
| Yorath Island | 36-6-W3 | May 19 - 25 | 54.0 | 474.1 | 0.3 |
| | | June 13 - 15 | 45.0 | 474.0 | 0.2 |
| | | July 11 - 13 | 45.0 | 474.0 | 0.2 |
| | | August 1 - 3 | 45.0 | 474.0 | 0.2 |
| Clarkboro Ferry | 38-4-W3 | May 25 - 27 | 44.0 | 462.1 | 0.5 |
| | | June 15 - 17 | 45.0 | 462.1 | 0.5 |
| | | July 14 - 15 | 45.0 | 462.1 | 0.5 |
| | | August 4 - 5 | 45.0 | 462.1 | 0.5 |
| Fenton Ferry | 46A-25-W2 | May 30 - June 1 | 46.0 | 418.3 | 0.4 |
| Fenton Ferry | 47A-25-W2 | June 21-23 | 45.0 | 418.3 | 0.4 |
| | | July 18-20 | 45.0 | 418.3 | 0.4 |
| | | August 8 - 10 | 45.0 | 418.3 | 0.4 |
| Swift Current Creek (U/S Reservoir) | 19-13-W3 | May 16 - 18 | | | |

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* - Provided by SaskWater Hydrology Service, Operation Planning Section, (November 4, 1988).
  - Discharges presented are averaged mean daily discharges for the range of sample dates.

** - Because of the daily fluctuations in releases downstream of Lake Diefenbaker, mean daily discharges presented may not accurately reflect those which occurred during sample times.

Appendix 2: Invertebrate fauna sampled by dredging at 5 sites on the north and south sides of the South Saskatchewan River in 1988.

| | Estuary Ferry | | Gardiner Dam | | | Yorath Island | | Clarkboro Ferry | | Fenton Ferry | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | North | South | North | M[a] | South | North | South | North | South | North | South | |
| Ephemeroptera | | | | | | | | | | | | |
| Siphlonuridae | - | - | - | 1 | - | 2 | 2 | - | 11 | 5 | 1 | 22 |
| Ephemeridae | 2 | 30 | - | 1 | - | 50 | 44 | 11 | 80 | 88 | 62 | 368 |
| Heptageniidae | 1 | 2 | - | - | - | 14 | 11 | - | 2 | 1 | - | 31 |
| Tricorythidae | - | - | - | - | - | - | 1 | - | - | - | - | 1 |
| Baetidae | - | - | - | 3 | - | 3 | - | - | 1 | 6 | - | 13 |
| Caenidae | - | - | - | - | - | - | 1 | 2 | - | 4 | 1 | 8 |
| Trichoptera | | | | | | | | | | | | |
| Hydropsychidae | - | - | - | - | - | 81 | 10 | 1 | 91 | 1 | 5 | 189 |
| Lepidostomatidae | - | - | - | - | - | - | - | - | 10 | - | 1 | 11 |
| Polycentropodidae | - | - | - | - | - | - | - | - | 1 | 2 | 3 | 6 |
| Other | 1 | - | - | - | - | 3 | - | 3 | 3 | 1 | - | 11 |
| Diptera | | | | | | | | | | | | |
| Chironomidae | 58 | 2 | 19 | 924 | 1 | 65 | 24 | 241 | 311 | 204 | 93 | 1 942 |
| Simuliidae | - | - | - | 1 | - | - | - | - | 11 | - | - | 12 |
| Ceratopogonidae | - | - | - | - | - | - | 1 | 4 | 1 | - | - | 6 |
| Chaoboridae | - | - | - | 2 | - | - | - | - | 2 | - | - | 4 |
| Tabanidae | - | - | - | - | - | - | - | 1 | 1 | 7 | - | 9 |
| Other | 2 | - | 1 | 2 | - | - | - | - | 2 | - | 1 | 8 |
| Coleoptera | | | | | | | | | | | | |
| Haliplidae | - | - | - | - | - | - | - | 4 | - | - | - | 4 |
| Dytiscidae | 1 | - | - | 1 | - | - | - | 1 | 1 | - | - | 4 |
| Gyrinidae | - | - | - | - | - | - | - | - | - | 1 | - | 1 |
| Odonata | | | | | | | | | | | | |
| Gomphidae | - | 1 | - | - | - | - | 1 | 1 | - | 2 | 3 | 8 |
| Coenagrionidae | - | - | - | - | - | - | - | - | 5 | 9 | 4 | 18 |
| Hemiptera | | | | | | | | | | | | |
| Corixidae | - | - | - | 1 | - | - | - | 21 | 4 | - | 1 | 27 |
| Plecoptera | | | | | | | | | | | | |
| Perlodidae | - | - | - | 1 | - | - | - | - | 1 | 9 | 2 | 13 |
| Hirudinea | - | 1 | - | 9 | - | - | - | - | 1 | - | - | 11 |
| Amphipoda | | | | | | | | | | | | |
| Gammaridae | - | - | - | 40 | - | 2 | 3 | 1 125 | 379 | 223 | 227 | 1 999 |
| Decapoda | - | - | - | - | - | - | 14 | - | - | 2 | 1 | 17 |
| Sphaeriidae | 1 | - | - | 24 | 2 | 68 | 31 | 30 | 7 | 93 | 71 | 327 |
| Gastropoda | - | - | - | 3 | - | - | - | 91 | 98 | 32 | 29 | 253 |
| Oligochaeta | 2 | 42 | 114 | 14 | 4 | 199 | 7 | 1 822 | 94 | 592 | 600 | 3 490 |
| Total no. | 68 | 78 | 134 | 1 027 | 7 | 487 | 150 | 3 358 | 1 117 | 1 282 | 1 105 | 8 813 |
| No. dredges | 16 | 9 | 6 | 21 | 6 | 12 | 13 | 11 | 11 | 12 | 12 | 129 |
| Wet weight, mg | 170 | 400 | 90 | 4 710 | 20 | 15 035 | 9 420 | 10 030 | 8 530 | 15 210 | 10 280 | 73 895 |

a: Ekman dredge in mid channel

Appendix 3: Invertebrate fauna sampled by Surber sampler at 5 sites on the north and south sides of the South Saskatchewan River.

| | Estuary Ferry | | Gardiner Dam | | Yorath Island | | Clarkboro Ferry | | Fenton Ferry | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | North | South | North | South | North | South | North | South | North | South | |
| Ephemeroptera | | | | | | | | | | | |
| Siphlonuridae | 3 | 6 | - | - | 24 | 4 | 10 | 65 | 29 | 59 | 200 |
| Ephemeridae | 44 | 37 | - | - | 28 | 50 | 5 | 49 | 80 | 205 | 498 |
| Heptageniidae | 11 | 23 | - | - | 145 | 32 | 3 | 30 | 46 | 60 | 350 |
| Tricorythidae | 2 | - | - | - | - | - | 15 | 37 | 18 | 12 | 84 |
| Baetidae | - | - | - | - | 5 | 1 | 1 | 44 | 19 | 81 | 151 |
| Caenidae | - | - | - | - | - | 1 | - | 4 | 2 | 13 | 20 |
| Trichoptera | | | | | | | | | | | |
| Hydropsychidae | 23 | 117 | - | - | 227 | 65 | 5 | 551 | 695 | 521 | 2 204 |
| Lepidostomatidae | - | - | - | - | 1 | - | 1 | 4 | 9 | 37 | 52 |
| Polycentropodidae | - | 18 | - | - | 3 | 1 | 1 | 8 | 97 | 11 | 139 |
| Other | - | 4 | - | - | 9 | 1 | 1 | 9 | 14 | 14 | 52 |
| Diptera | | | | | | | | | | | |
| Chironomidae | 3 | 108 | 15 | 25 | 16 | 22 | 28 | 129 | 172 | 99 | 617 |
| Simuliidae | 27 | - | 1 | - | - | - | - | 1 | - | - | 29 |
| Ceratopogonidae | - | - | 1 | - | - | - | - | - | - | - | 1 |
| Chaoboridae | - | - | - | - | - | - | - | 10 | 1 | 1 | 12 |
| Tipulidae | 4 | - | - | - | - | - | - | - | - | - | 4 |
| Rhagionidae | - | - | - | - | - | - | - | - | 3 | 2 | 5 |
| Other | - | - | 2 | 1 | - | - | - | 4 | - | - | 7 |
| Coleoptera | | | | | | | | | | | |
| Dytiscidae | - | - | - | 1 | - | - | 2 | - | - | - | 3 |
| Other | - | 1 | 2 | - | - | - | - | - | - | - | 3 |
| Odonata | | | | | | | | | | | |
| Gomphidae | 2 | 5 | - | - | 2 | - | - | - | 2 | - | 11 |
| Coenagrionidae | - | - | - | - | 1 | - | 46 | 2 | - | 2 | 51 |
| Hemiptera | | | | | | | | | | | |
| Corixidae | - | - | - | - | - | - | 57 | 6 | 21 | 2 | 86 |
| Plecoptera | | | | | | | | | | | |
| Perlodidae | 2 | 1 | - | - | - | - | - | - | - | 2 | 5 |
| Perlidae | - | 1 | - | - | 1 | - | - | - | - | - | 2 |
| Hirudinea | - | - | - | - | - | - | 2 | 1 | - | - | 3 |
| Amphipoda | | | | | | | | | | | |
| Gammaridae | - | 1 | - | 1 | 5 | 8 | 2 354 | 705 | 45 | 334 | 3 453 |
| Decapoda | - | - | - | - | 5 | 28 | 3 | - | 5 | 7 | 48 |
| Sphaeriidae | - | 9 | - | - | 65 | 53 | 286 | 2 | 34 | 65 | 514 |
| Gastropoda | - | 1 | - | - | - | - | 452 | 62 | 105 | 3 | 623 |
| Oligochaeta | - | 20 | 261 | 3 | 15 | 2 | 370 | 50 | 22 | 103 | 846 |
| Total no. | 121 | 352 | 282 | 31 | 552 | 268 | 3 642 | 1 773 | 1 419 | 1 633 | 10 073 |
| No. samples | 12 | 11 | 6 | 8 | 12 | 9 | 10 | 9 | 12 | 12 | 101 |
| Wet weight, mg | 1 830 | 3 730 | 160 | 180 | 9 620 | 11 740 | 17 700 | 12 380 | 20 560 | 13 510 | 91 410 |

Appendix 4: Invertebrate fauna collected by sweep net at 2 locations on the South Saskatchewan River in 1988.

| | Yorath Island<br>May 19 | Clarkboro Ferry<br>June 16 |
|---|---|---|
| Ephemeroptera | | |
| Siphlonuridae | 66 | 2 |
| Ephemeridae | | 7 |
| Heptageniidae | 53 | |
| Tricorythidae | 1 | |
| Odonata | | |
| Gomphidae | 1 | |
| Coenagrionidae | 4 | |
| Hemiptera | | |
| Corixidae | 12 | 6 |
| Trichoptera | | |
| Hydropsychidae | 7 | 1 |
| Coleoptera | | |
| Dytiscidae | 1 | 5 |
| Gyrinidae | | 1 |
| Hydraenidae | | 1 |
| Diptera | | |
| Chironomidae | | 1 |
| Simuliidae | | 1 |
| Chaoboridae | | 1 |
| Gastropoda | | 250 |
| Total no. organisms | 145 | 276 |
| No. of samples | 3 | 3 |

Appendix 5: Reproductive condition of fish caught in gillnets in the South Saskatchewan River between May 9 and June 10, 1988. (n=315 fish)

| | | Sauger | | Walleye | | Goldeye | | Lake whitefish | | Northern pike | | Longnose sucker | | Common white sucker | | Shorthead redhorse | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Male | Female | Male | Female | Male | Female | Male | Female | Male | Female | Male | Female | Male | Female | Male | Female | Total | % |
| Estuary Ferry | Ripe | 4 | - | 2 | 1 | 9 | 6 | - | - | - | - | 3 | 6 | 2 | 3 | - | - | 36 | 11.4 |
| | Spent | - | 1 | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 0.6 |
| | Other | 1 | 1 | 2 | - | - | 1 | - | - | - | - | 2 | 4 | - | 1 | - | - | 12 | 3.8 |
| Gardiner Dam | Ripe | - | - | 2 | 2 | - | - | 62 | 46 | - | 1 | 6 | 3 | 1 | 7 | 6 | 9 | 145 | 46.0 |
| | Spent | - | - | - | - | - | - | - | 4 | - | 1 | - | - | - | 3 | - | - | 5 | 1.6 |
| | Other | - | - | - | - | - | - | 13 | 26 | - | - | - | - | - | | 1 | 4 | 47 | 15.0 |
| Yorath Island | Ripe | - | - | - | 1 | - | - | - | - | - | - | - | - | 1 | 6 | - | - | 8 | 2.5 |
| | Spent | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | Other | - | - | - | 1 | - | - | - | - | 2 | - | - | - | - | - | - | - | 3 | 0.9 |
| Clarkboro Ferry | Ripe | - | - | 2 | 3 | - | - | - | - | - | - | 5 | 7 | 4 | 5 | 1 | 2 | 29 | 9.2 |
| | Spent | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | 0.3 |
| | Other | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | 2 | 3 | 0.9 |
| Fenton Ferry | Ripe | - | - | 1 | - | - | - | - | - | - | - | 1 | 1 | 2 | 5 | 3 | 3 | 16 | 5.1 |
| | Spent | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | 1 | 0.3 |
| | Other | 1 | - | 1 | 3 | 1 | - | - | - | - | - | - | 1 | - | - | - | - | 7 | 2.2 |

Appendix 6: Length, weight and age data for sauger caught in gillnets in the South Saskatchewan River in 1988.

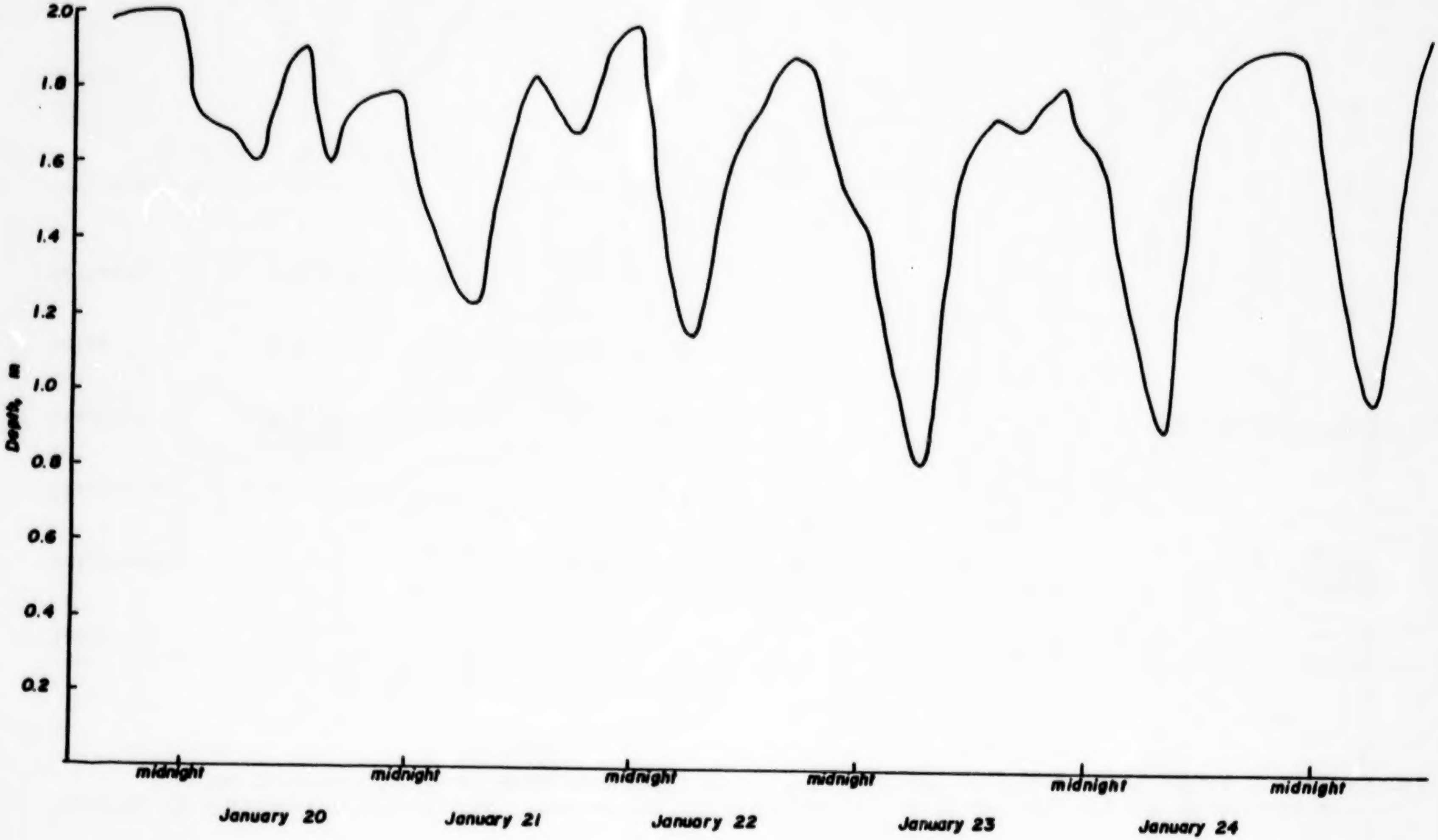
| Sample # | Fork length (cm) | Weight (g) | Age (yr) |
|---|---|---|---|
| 1-01 | 34.2 | 325 | 3 |
| 1-02 | 31.5 | 250 | 3 |
| 2-03 | 29.2 | 238 | 5 |
| 2-03 | 30.7 | 300 | 5 |
| 2-10 | 36.2 | 400 | 5 |
| 2-11 | 35.8 | 450 | 6 |
| 11-09 | 50.2 | 1325 | 13 |
| 15-03 | 19.1 | 62 | 2 |
| 24-04 | 51.4 | 1300 | 17 |
| 25-06 | 42.7 | 800 | 8 |

Appendix 7: Fish stocking record for reservoirs in the Saskatoon Southeast Water Supply System.

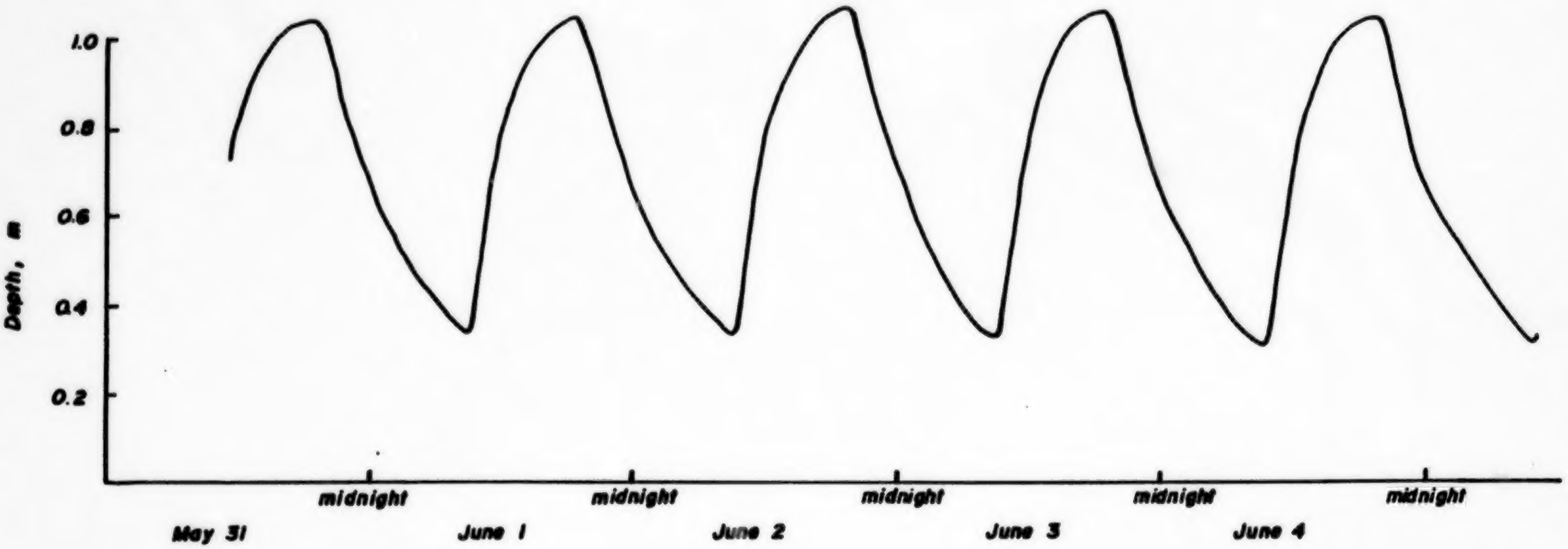
| DATE | SPECIES | SIZE | AMOUNT |
|---|---|---|---|
| **BLACKSTRAP RESERVOIR** | | | |
| 1970 | Walleye | Fry | 1 000 000 |
| 1973 | Walleye | Fry | 300 000 |
| 1975 | Walleye | Fry | 300 000 |
| 1977 | Walleye | Fry | 200 000 |
| 1979 | Walleye | Fry | 100 000 |
| 1981 | Walleye | Fry | 200 000 |
| 1982 | Walleye | Fry | 200 000 |
| 1985 | Walleye | Fry | 500 000 |
| **BRADWELL RESERVOIR** | | | |
| 1970 | Walleye | Fry | 100 000 |
| **DELLWOOD RESERVOIR** | | | |
| 1970 | Walleye | Fry | 100 000 |
| 1986 | Walleye | Fry | 600 000 |
| 1987 | Walleye | Fry | 600 000 |
| **ZELMA RESERVOIR** | | | |
| 1970 | Walleye | Fry | 200 000 |

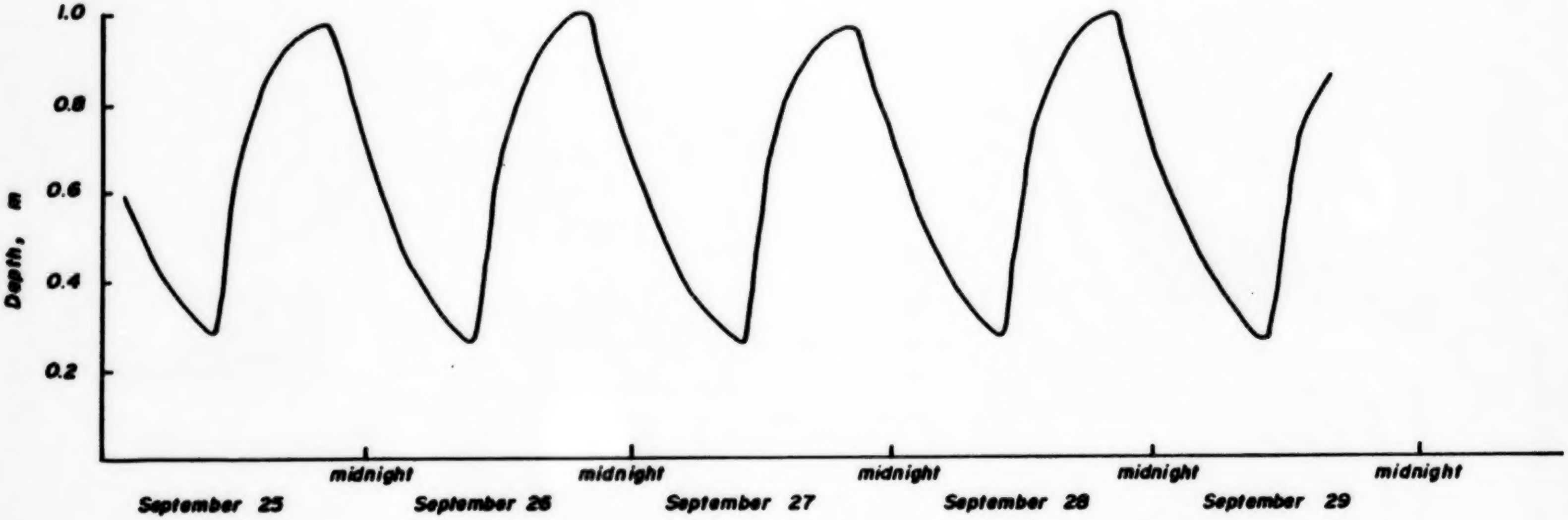
Appendix 8: Equations describing the length-weight relationships of 4 fish species caught in reservoirs of the Saskatoon Southeast Water Supply System in 1988 (W-weight in grams; L=fork length in centimeters).

| | Walleye | Lake whitefish | Northern pike | Yellow perch |
|---|---|---|---|---|
| Broderick | - | $W=0.0102L^{3.09146}$ | $W=0.0052L^{3.07148}$ | - |
| Brightwater | - | $W=0.0097L^{3.14996}$ | - | - |
| Blackstrap | $W=0.0078L^{3.09229}$ | $W=0.0193L^{2.9606}$ | - | - |
| Bradwell | $W=0.0074L^{3.1092}$ | $W=0.2039L^{2.3305}$ | - | $W=0.0072L^{3.2268}$ |
| Zelma | $W=0.0060L^{3.1912}$ | $W=0.0247L^{2.9058}$ | - | - |
| Dellwood | $W=0.0127L^{2.9429}$ | - | - | - |



Appendix 9 Variations in water level measured below Gardiner Dam on the South Saskatchewan River on selected dates in January, May and September, 1988.





Appendix 9 Continued